

**Repair Manuals for other  
Briggs & Stratton Engines:**

- 273521 Twin Cylinder OHV Air-Cooled Engines
- 271172 Twin Cylinder L-Head Air-Cooled Engines
- 270962 Single Cylinder L-Head Air-Cooled Engines
- 276535 Two-Cycle Snow Engines
- CE8069 Out of Production Engines (1919-1981)



Briggs & Stratton



**Single Cylinder OHV  
Air-Cooled Engines**



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SINGLE CYLINDER OHV AIR-COOLED ENGINES



# FORWARD

This manual was written to assist engine technicians and service personnel with the repair and maintenance procedures for Briggs & Stratton engines. It assumes that persons using this manual have been properly trained in and are familiar with the servicing procedures for these products, including the proper use of required tools and safety equipment and the application of appropriate safety practices. Persons untrained or unfamiliar with these procedures or products should not attempt to perform such work.

Proper maintenance and repair is important to safe, reliable operation of all engines and engine-driven systems. The troubleshooting, testing, maintenance, and repair procedures described in this manual are appropriate for the Briggs & Stratton engines described herein. Alternative methods or procedures may pose risk to personal safety and the safety and/or reliability of the engine and are not endorsed or recommended by Briggs & Stratton.

All information, illustrations, and specifications contained in this manual were based on the data available at the time of publication. Briggs & Stratton Corporation reserves the right to change, alter, or otherwise improve the product or the product manuals at any time without prior notice.

Briggs & Stratton offers two complementary publications to enhance understanding of engine technology, maintenance, and repair. (Neither publication, however, is a substitution for a recognized training program for engine technicians.)

- For consumers, *Small Engine Care & Repair* (p/n 274041) provides a comprehensive overview of how small air-cooled engines work, basic troubleshooting, and step-by-step maintenance procedures.
- For engine technicians and consumers alike, an in-depth study of engine theory and operation can be found in the textbook *Small Engines* (p/n CE8020).

Both publications can be purchased at [BRIGGSandSTRATTON.COM](http://BRIGGSandSTRATTON.COM) or through a local Authorized Briggs & Stratton Service Dealer.

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**This Engine Repair Manual includes the following  
Engine Models:**

- **MODEL 110000 HORIZONTAL SERIES**
- **MODEL 120000 HORIZONTAL SERIES**
- **MODEL 150000 HORIZONTAL SERIES**
- **MODEL 200000 HORIZONTAL SERIES**
- **MODEL 210000 HORIZONTAL SERIES**
- **MODELS 97700 & 99700 VERTICAL SERIES**
- **MODEL 110000 VERTICAL SERIES**
- **MODEL 120000 VERTICAL SERIES**
- **MODEL 210000 VERTICAL SERIES**
- **MODEL 280000 VERTICAL SERIES**
- **MODEL 310000 VERTICAL SERIES**
- **MODEL 330000 VERTICAL SERIES**

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## **SECTION 1 - SAFETY, MAINTENANCE, AND ADJUSTMENTS**

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# ENGINE SAFETY

This repair manual contains safety information that is designed to:

- Make you aware of hazards associated with engines.
- Inform you of the risk of injury associated with those hazards.
- Tell you how to avoid or reduce the risk of injury.

1

## Signal Words in Safety Messages

The safety alert symbol (⚠) is used to identify safety information about hazards that can result in personal injury.

A signal word (**DANGER**, **WARNING**, or **CAUTION**) is used with the alert symbol to indicate the likelihood and the potential severity of injury. In addition, a hazard symbol may be used to represent the type of hazard.

**DANGER** indicates a hazard which, if not avoided, will result in death or serious injury.

**WARNING** indicates a hazard which, if not avoided, could result in death or serious injury.

**CAUTION** indicates a hazard which, if not avoided, could result in minor or moderate injury.


**NOTICE** indicates a situation that could result in damage to the product.

Prior to work, read and understand the section(s) of this manual that pertain to the job. Follow all safety warnings.













- Wear suitable eye protection.
- When servicing engines or equipment, prevent accidental starting by disconnecting spark plug wire from the spark plug(s) and disconnect negative battery cable.
- Periodically clean engine. Keep governor parts free of dirt, grass, and other debris which can affect engine speed and cooling.
- Always use fresh gasoline. Stale fuel can cause gum deposits in the carburetor


and cause leakage, flow restrictions, or other failures.

- Check fuel lines and fittings frequently for cracks or leaks and replace if necessary.


 <b>WARNING</b>
Before attempting to service this equipment, read and understand this manual and the operating instructions of the engine and the equipment it powers.
Failure to follow instructions could result in property damage, serious injury (including paralysis) or even death.

## Hazard Symbols and Meanings


 FIRE	 EXPLOSION	 ELECTRIC SHOCK
 EXPLOSIVE PRESSURE	 HOT SURFACE	 GOGGLES
 ENTANGLEMENT	 KICKBACK	 SEVERING
 TOXIC FUMES	 READ MANUAL	 CHEMICAL BURNS



 **WARNING**

Briggs & Stratton does not approve or authorize the use of these engines on 3-wheel All Terrain Vehicles (ATV's), motor bikes, fun/recreational go-karts, aircraft products, or vehicles intended for use in competitive events. Use of these engines in such applications could result in property damage, serious injury (including paralysis), or even death.

 **WARNING**

The engine exhaust from this product contains chemicals known the State of California to cause cancer, birth defects, and other reproductive harm.

 **WARNING**

 **Gasoline and its vapors are extremely flammable and explosive.**  
 **Fire or explosion can cause severe burns or death.**

**When adding fuel:**

- Turn engine OFF and let engine cool for at least 2 minutes before removing the fuel cap.
- Fill fuel tank outdoors or in a well-ventilated area.
- Do not overfill fuel tank. To allow for expansion of the gasoline, do not fill above the bottom of the fuel tank neck.
- Keep gasoline away from sparks, open flames, pilot lights, heat and other ignition sources.
- Check fuel lines, tank, cap, and fittings frequently for cracks or leaks. Replace if necessary.
- If fuel spills, wait until it evaporates before starting engine.

**When starting engine:**

- Make sure spark plug, muffler, fuel cap, and air cleaner are in place.
- Do not crank engine with spark plug removed.
- If fuel spills, wait until it evaporates before starting engine.
- If engine floods, set choke (if equipped) to **OPEN/RUN** position. Place throttle (if equipped) in **FAST** and crank until engine starts.

**When operating equipment:**

- Do not tip engine or equipment at an angle which would cause fuel to spill.
- Do not choke carburetor to stop engine.
- Never start or run the engine with the air cleaner assembly (if equipped) or the air filter (if equipped) removed.

**When changing oil:**


- If you drain the oil from the top oil fill tube, the fuel tank must be empty or fuel can leak out and result in a fire or explosion.



**When transporting equipment:**

- Transport with fuel tank empty or with fuel shut-off valve set to OFF.


**When storing gasoline or equipment with fuel in the tank:**



- Store away from furnaces, stoves, water heaters, or other appliances that have a pilot light or other ignition source because they can ignite gasoline vapors.

 **WARNING**

 **Running engines produce heat. Engine parts, especially mufflers, become extremely hot.**  
 **Severe thermal burns can occur on contact.**  
**Combustible debris, such as leaves, grass, brush, etc. can catch fire.**

- Allow muffler, engine cylinder fins, and radiator to cool before touching.
- Remove accumulated debris from muffler area and cylinder fins.
- It is a violation of California Public Resource Code, Section 4442, to use or operate the engine on any forest-covered, brush-covered, or grass-covered land unless the exhaust system is equipped with a spark arrester, as defined in Section 4442, maintained in effective working order. Other States and Federal jurisdictions may have similar laws. Contact the original equipment manufacturer, retailer, or dealer to obtain a spark arrester designed for the exhaust system installed on this engine.

 **WARNING**


 **Unintentional sparking can result in fire or electrical shock.**  
 **Unintentional start-up can result in entanglement, traumatic amputation, or severe lacerations.**


Before performing adjustments or repairs:

- Disconnect spark plug wire and keep it away from spark plug.
- Disconnect the negative (-) battery terminal.

When testing for spark:

- Use approved spark plug tester.
- Do not check for spark with spark plug removed.

 **WARNING**

 **Engines give off carbon monoxide, an odorless, colorless, poison gas.**  
**Breathing carbon monoxide can cause nausea, fainting, or death.**

- Start and run engine outdoors.
- Do not start or run engine in an enclosed area, even if doors and windows are open.

1



**WARNING**

**Starting engine creates sparking. Sparking can ignite nearby flammable gases.**



**Explosion and fire could result.**

- If there is a natural or LP gas leak in the area, do not start engine.
- Do not use pressurized starting fluids because vapors are flammable.

**WARNING**

**Rotating parts can contact or entangle hands, feet, hair, clothing, or accessories.**



**Traumatic amputation or severe lacerations can result.**

- Operate equipment with guards in place.
- Keep hands and feet away from rotating parts.
- Tie up long hair and remove jewelry.
- Do not wear loose-fitting clothing, dangling drawstrings, or items that could become entangled in the equipment.

**WARNING**

**Charging batteries produce hydrogen gas. Do not store or charge a battery near an open flame or device that utilizes a pilot light or can create a spark.**

**WARNING**

**Kerosene and its vapors are extremely flammable and should be handled with the same precautions as gasoline.**

**WARNING**

**Damaged, worn, or loose fuel components can leak fuel. Explosion or fire could result.**



- All fuel components should be in good condition and properly maintained.
- Repairs should only be made with factory approved parts.
- Repair work should be done by a qualified technician.
- Flexible supply lines should be checked regularly to make sure they are in good condition.

**WARNING**

**Rapid retraction of starter cord (kickback) will pull hand and arm toward engine faster than you can let go. Broken bones, fractures, bruises, or sprains could result.**

- When starting engine, pull the starter cord slowly until resistance is felt and then pull rapidly to avoid kickback.
- Remove all external equipment/engine loads before starting engine.
- Direct-coupled equipment components, such as but not limited to blades, impellers, pulleys, and sprockets, must be securely attached.

**WARNING**

**Prolonged or repeated contact with used motor oil could cause injury.**

- Used motor oil has been shown to cause skin cancer in certain laboratory animals.
- Thoroughly wash exposed areas with soap and water.

# BRIGGS & STRATTON NUMERICAL IDENTIFICATION SYSTEM

## YOUR KEY TO THE WORLD'S FINEST ENGINES

This chart explains the unique Briggs & Stratton numerical model designation system. It is possible to determine most of the important mechanical features of the engine by merely knowing the model number. Here is how it works:

- A. The first one or two digits indicate the approximate CUBIC INCH DISPLACEMENT.
- B. The first digit after the displacement indicates the BASIC DESIGN SERIES, relating to cylinder construction, ignition, general configuration, etc.
- C. The second digit after the displacement indicates ORIENTATION OF CRANKSHAFT.
- D. The third digit after the displacement indicates TYPE OF BEARINGS, and whether or not the engine is equipped with REDUCTION GEAR or AUXILIARY DRIVE.
- E. The last digit indicates the TYPE OF STARTER.



## BRIGGS & STRATTON MODEL NUMBERING SYSTEM

FIRST DIGIT AFTER DISPLACEMENT A	SECOND DIGIT AFTER DISPLACEMENT B	THIRD DIGIT AFTER DISPLACEMENT C	FOURTH DIGIT AFTER DISPLACEMENT D	FIFTH DIGIT AFTER DISPLACEMENT E
<b>CUBIC INCH DISPLACEMENT</b>	<b>BASIC DESIGN SERIES</b>	<b>CRANKSHAFT ORIENTATION</b>	<b>PTO BEARING, REDUCTION GEAR, AUXILIARY DRIVE, LUBRICATION</b>	<b>TYPE OF STARTER</b>
2	0	0 to 4 - Horizontal Shaft	0 - Plain Bearing/DU Non-Flange Mount	0 - Without Starter
5	1	5 to 9 - Vertical Shaft	1 - Plain Bearing Flange Mounting	1 - Rope Starter
6	2	A to G - Horizontal Shaft	2 - Sleeve Bearing Flange Mounting Splash Lube	2 - Rewind Starter
8	3	H to Z - Vertical Shaft	3 - Ball Bearing Flange Mounting Splash Lube	3 - Electric Starter Only 110 or 230 Volt Gear Drive
9	4		4 - Ball Bearing Flange Mounting Pressure Lubrication	4 - Electric Starter/ 110 or 230 Volt Gear Drive with Alternator
10	5		5 - Plain Bearing Gear Reduction (6 to 1) CCW Rotation	5 - Electric Starter Only 12 or 24 Volt Gear Drive
11	6		6 - Ball Bearing Gear Reduction (2 to 1) CCW Rotation	6 - Alternator Only
12	7		7 - Plain Bearing Pressure Lubrication	7 - Electric Starter 12 or 24 Volt Gear Drive with Alternator
13	8		8 - Plain Bearing Auxiliary Drive (PTO) Perpendicular to Crankshaft	8 - Vertical Pull Starter or Side Pull Starter
15	9		9 - Plain Bearing Auxiliary Drive Parallel to Crankshaft	9 - Mechanical Starter
16	A to Z		A - Plain Bearing Pressure Lubrication Without Oil Filter	A - Electric Starter 12 or 24 Volt Gear Drive with Alternator and Inverter
18				
19				
20				
21				
22				
23				
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28				
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52				
54				
58				
61				

**EXAMPLE - To identify Model 30344Z:**

30	3	4	4	Z
30 Cubic Inch	Design Series 3	Horizontal Shaft	Ball Bearing Flange Mounting Pressure Lubrication	Electric Starter 12 or 24 Volt Gear Drive with Alternator

**TYPE 1234-01.** The type number identifies the engines mechanical parts, color of paint, decals, governed speed, and Original Equipment Manufacturer.

**CODE 01061201.** The code is the manufacturing date and is read as follows:

YEAR	MONTH	DAY	ASSEMBLY LINE AND MANUFACTURING PLANT
01	06	12	01

# ENGINE MAINTENANCE

## Fuel and Oil Recommendations

### Fuel must meet these requirements:

- Clean, fresh, unleaded gasoline.
- A minimum of 87 octane / 87 AKI (90 RON).
- Gasoline with up to 10% ethanol (gasahol) or up to 15% MTBE (methyl tertiary butyl ether) is acceptable.
- **NOTICE:** Do not use unapproved gasoline, such as E85. Do not mix oil in gasoline or modify the engine to run on alternate fuels. This will damage the engine components and **void the engine warranty.**

To protect the fuel system from gum formation, mix a fuel stabilizer into the fuel. All fuel is not the same. If starting or performance problems occur, change fuel providers or change brands. This engine is certified to operate on gasoline. The emissions control system for this engine is EM (Engine Modifications).

### High Altitude

At altitudes over 5,000 feet (1524 meters), a minimum 85 octane / 85 AKI (89 RON) gasoline is acceptable. To remain emissions compliant, high altitude adjustment is required. Operation without this adjustment will cause decreased performance, increased fuel consumption, and increased emissions.

Operation of the engine at altitudes below 2,500 feet (762 meters) with the high altitude kit is not recommended.

### Fresh Start® Fuel Cap

Some engines are equipped with a Fresh Start® fuel cap. The Fresh Start fuel cap is designed to hold a cartridge (sold separately) that contains fuel stabilizer.

### Oil must meet these requirements:

- Briggs & Stratton Warranty Certified oils are recommended for best performance.
- Other high-quality detergent oils are acceptable if classified for service SF, SG, SH, SJ or higher.
- Do not use special additives.

Outdoor temperatures determine the proper oil viscosity for the engine. Use the chart (Figure 1) to select the best viscosity for the outdoor temperature range expected.

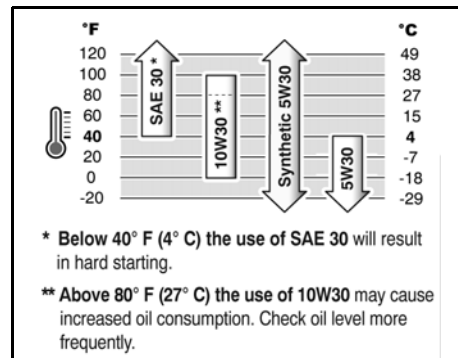


Figure 1

## Maintenance Chart

<b>First 5 Hours</b>
<ul style="list-style-type: none"> <li>• Change oil</li> </ul>
<b>Every 8 Hours or Daily</b>
<ul style="list-style-type: none"> <li>• Check engine oil level</li> <li>• Clean area around muffler and controls</li> <li>• Clean finger guard</li> </ul>
<b>Every 25 Hours or Annually</b>
<ul style="list-style-type: none"> <li>• Clean air filter*</li> <li>• Clean pre-cleaner*</li> </ul>
<b>Every 50 Hours or Annually</b>
<ul style="list-style-type: none"> <li>• Change engine oil</li> <li>• Check muffler and spark arrester</li> </ul>
<b>Annually</b>
<ul style="list-style-type: none"> <li>• Replace air filter</li> <li>• Replace pre-cleaner</li> <li>• Replace spark plug</li> <li>• Replace fuel filter</li> <li>• Clean air cooling system*</li> </ul>

\* In dusty conditions or when airborne debris is present, clean more often.

## Flywheel Brake

### Model Series 97700, 99700, 110000, 120000 Vertical Shaft

The flywheel brake is part of the safety control system required for some applications. While running at FAST speed position, the flywheel brake **MUST** stop the engine within three seconds, when the operator releases the equipment safety control.

#### Test Brake Torque

1. Disconnect spark plug wire.
2. Unscrew and/or pry off static guard (A, Figure 2).
3. Unscrew and remove fuel tank (B).

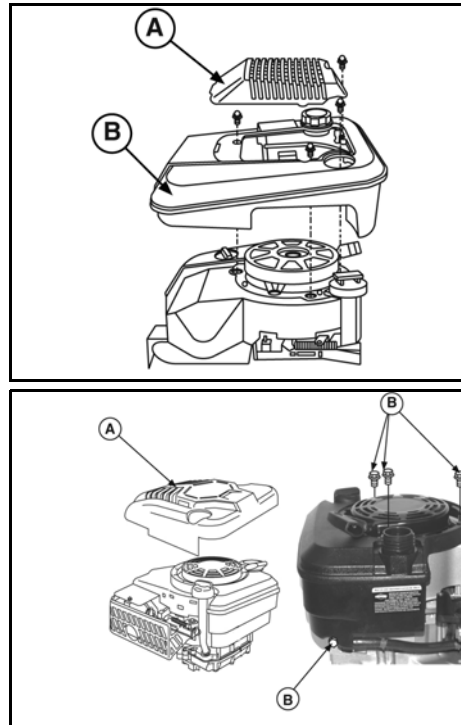


Figure 2

4. Remove dipstick and oil fill tube (A, Figure 3).
5. Unscrew and remove blower housing/rewind assembly (B).

1

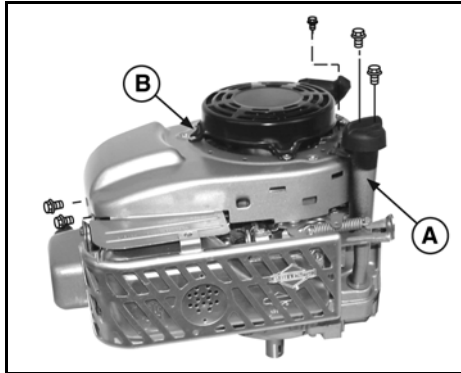


Figure 3

6. Using a torque wrench and socket to fit the flywheel nut, turn flywheel clockwise with brake engaged. While turning at a steady rate, torque reading should be 26 lb.-in. (3 Nm) or higher.
7. If reading is low, check thickness of brake pad. Replace brake assembly if thickness is less than 0.09" (2.28mm).
8. If brake pad thickness is acceptable, adjust control cable to position pad closer to flywheel when safety control is in RUN position.
9. Replace brake assembly if correct adjustment cannot be made.

#### Inspect Brake and Switches

1. Disconnect spring from brake anchor (A, Figure 4).
2. Disconnect stop switch wire from stop switch (B). If engine is equipped with an electric starter, disconnect both wires from the starter interlock switch (C).
3. Remove two screws (D) from brake bracket and remove bracket.

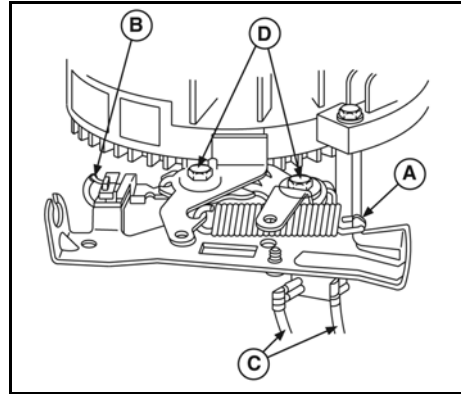


Figure 4

4. Inspect brake pad on brake lever. Replace brake assembly if thickness is less than 0.09" (2.28mm).
5. Test stop switch as described in Section 2.
6. Test electric starter interlock switch as described in Section 2.

#### Assemble Flywheel Brake

1. Install brake assembly on cylinder and torque mounting screws to values listed in Section 12 - Engine Specifications.
2. Install stop switch wire and bend end of wire 90°. Install wires on interlock switch, if equipped.
3. Install brake spring.
4. Actuate brake system to ensure proper movement, then test brake torque as previously described.
5. Install blower housing/rewind assembly, install dipstick tube and dipstick, and install fuel tank and static guard. Torque all screws to values listed in Section 12 - Engine Specifications.

### Combustion Chamber

Remove combustion chamber deposits every 500 hours or whenever the cylinder head is removed.

With the piston at Top Dead Center (TDC), scrape deposits from top of piston and upper bore with a plastic scraper.

Remove the loosened deposits from around the top ring land area using compressed air or a shop vacuum and a soft bristle brush.




**NOTICE:** Use care to prevent debris from entering push rod or oil return cavities in cylinder. Do not damage bore, top of piston, cylinder head, or cylinder head gasket surfaces.

It is not necessary to remove the discoloration marks on the piston, valves, and/or cylinder head. These marks are normal and will not affect engine operation.

### Air Filter

A correctly serviced air filter protects internal engine parts from airborne dirt and dust. Poor filter maintenance will allow dirt and dust to be drawn into the engine, causing wear to the intake system and contamination of the oil. Dirt in the oil forms an abrasive mixture which wears down moving parts.

**NOTE:** Snow engines do not have an air cleaner assembly. Please refer to Snow Hood Maintenance for disassembly procedures

	<b>WARNING</b>
	<b>Gasoline and its vapors are extremely flammable and explosive. Fire or explosion can cause severe burns or death.</b>
	<ul style="list-style-type: none"> <li>Never start or run the engine with the air cleaner assembly or the air filter removed.</li> </ul>

**NOTE:** Do not use pressurized air or solvents to clean the filter. Pressurized air can damage the filter and solvents will dissolve the filter.

1. Disassemble air cleaner system.

2. Gently tap air filter cartridge on a hard surface to loosen debris. Replace cartridge if very dirty.
3. Wash foam filters and pre-cleaners in warm, soapy water, then rinse and allow to air dry. Saturate foam filters in clean engine oil, then squeeze out excess oil. **DO NOT OIL PRE-CLEANERS.**
4. Drain and clean oil bath reservoirs, then re-fill with clean engine oil.
5. Reassemble the air cleaner system.

Figures 5 through 16 illustrate the various air cleaner systems found on Briggs & Stratton single-cylinder OHV engines.

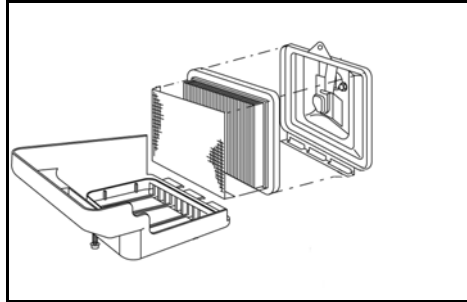


Figure 5

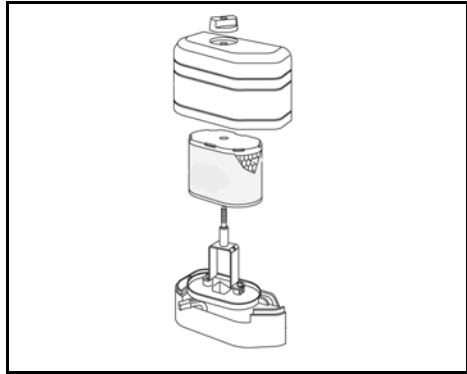


Figure 6

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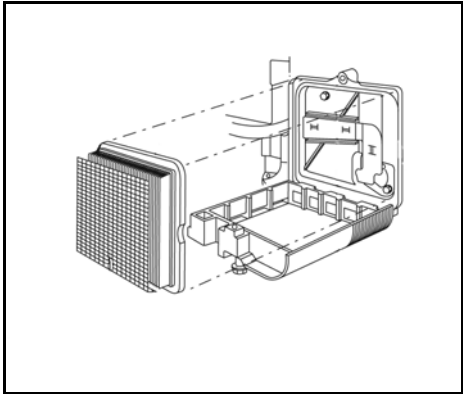


Figure 7

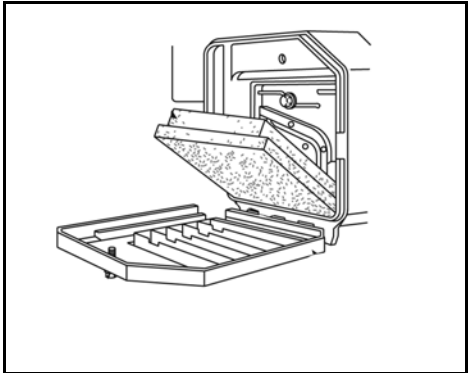


Figure 10

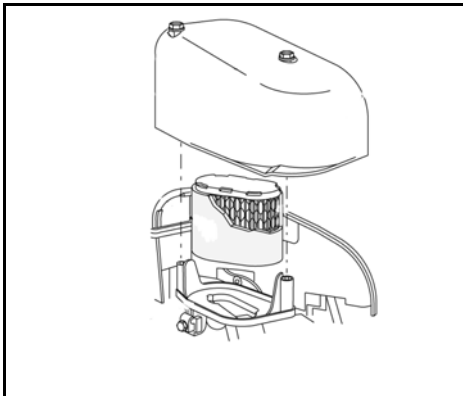


Figure 8

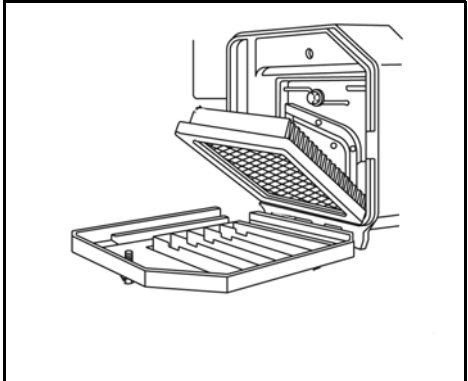


Figure 11

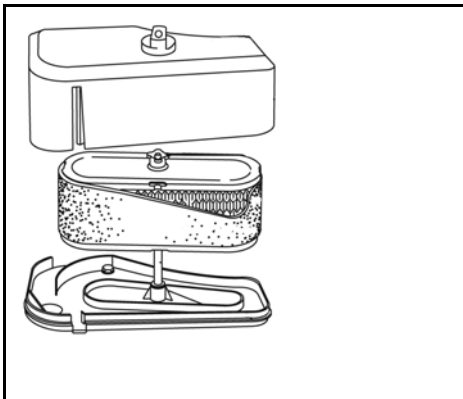


Figure 9

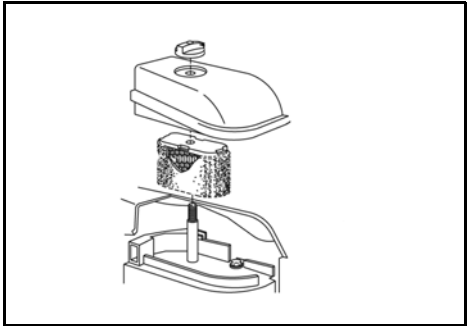


Figure 12

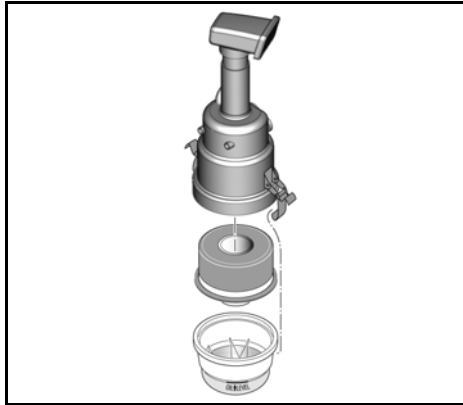


Figure 13

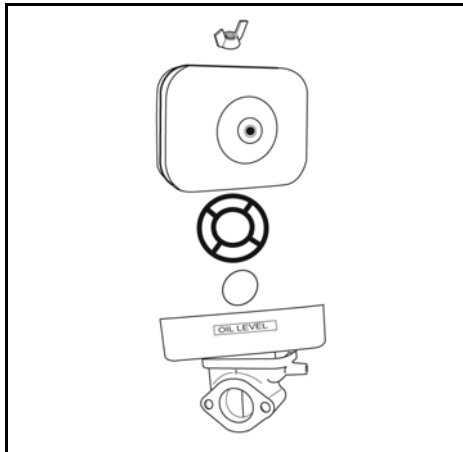


Figure 14

### Snow Hood

**NOTE:** Snow engines do not have an air cleaner assembly. Instead, a 1-piece or 2-piece snow hood is installed to protect the carburetor area, retain heat to resist carburetor icing, and provide a mounting surface for engine controls.

#### Remove

1. Remove choke knob (A, Figure 15 and Figure 16).
2. Remove fasteners and hood (B).
3. Disconnect stop switch wire (C) and primer hose (D).

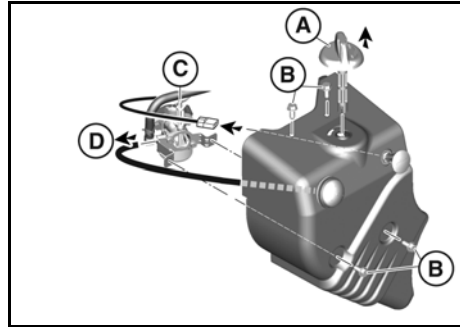


Figure 15

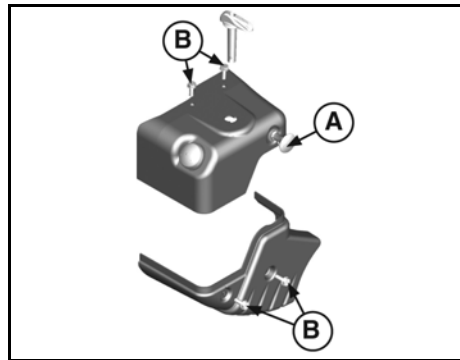


Figure 16

#### Inspection

1. Check hood for cracks or worn mounting holes. Replace if necessary.
2. Check primer hose for brittleness or leaks and check stop switch and wire for damage. Replace parts as necessary.




#### Install

1. Connect stop switch wire (C, Figure 15) and primer hose (D).
2. Install hood and fasteners (B).
3. Install choke knob (A) with tab under knob fitting into slot of hood. Actuate the choke knob to check for proper movement.

1



## Oil and Oil Filter

	<b>WARNING</b>
	<b>Gasoline and its vapors are extremely flammable and explosive.</b>
	<b>Fire or explosion can cause severe burns or death.</b>
<ul style="list-style-type: none"><li>• If you drain the oil from the top oil fill tube, the fuel tank must be empty or fuel can leak out and result in a fire or explosion.</li><li>• To empty the fuel tank, run the engine until it stops from lack of fuel.</li></ul>	

Change oil after the first 5 hours of operation. After that, change oil after every 50 hours of operation. Change oil more often if engine is operated in dirty or dusty conditions, under heavy loads, or in high ambient temperatures.

1. Remove oil drain plug from side or bottom of engine and drain oil while the engine is still warm.
2. Install drain plug.
3. Remove oil filter, if equipped.
  - Clean surface of filter mounting adapter.
  - Apply light coat of clean engine oil to new filter gasket.
4. Screw new filter on by hand until gasket contacts filter mounting adapter. Then tighten an additional 1/2 to 3/4 turn.
5. Fill crankcase with the correct amount of new oil.
6. Start engine and run at idle for a minute or so.
7. Shut engine off and wait for oil to settle back into the cylinder.
8. Check dipstick. If necessary, add more oil slowly to bring level to FULL mark on dipstick.

<b>NOTICE</b>
<b>Do not overfill. Overfilling can cause seals to fail, smoke from the exhaust, or overheating due to oil foaming.</b>

9. Replace oil fill cap and dipstick.
10. Start and run engine. Check for oil leaks.

## Spark Plug

Spark plugs should be replaced every year.

<b>NOTICE</b>
<b>Spark plugs have different thread “reach” and heat ranges. When changing a spark plug, use only the specified replacement, otherwise engine damage could occur.</b>

**NOTE:** In some areas, local law requires using resistor spark plugs to suppress radio frequency interference.

1. Disconnect spark plug wire.
2. Remove and inspect spark plug for wear and damage. Replace spark plug if electrodes are burned away, or the porcelain is cracked.
3. Do not blast clean spark plugs. Clean by scraping or wire brushing, and then washing in a commercial solvent.
4. Using a wire gage, check and set the gap (A, Figure 15) per Section 12 - Specifications.

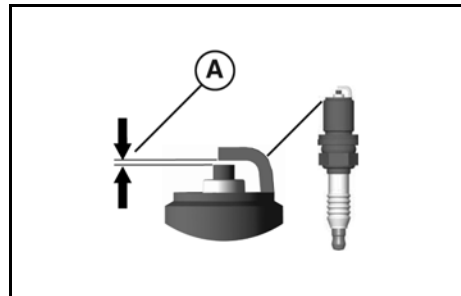




Figure 17

5. Re-install spark plug and torque to values listed in Section 12 - Specifications.
6. Connect spark plug wire.

## Cooling System

	<b>WARNING</b>
	<b>Running engines produce heat. Severe burns can occur on contact.</b>
<ul style="list-style-type: none"><li>• Allow muffler, engine cylinder fins, and radiator to cool before touching.</li><li>• Remove accumulated combustibles from muffler area and cylinder area.</li></ul>	

Dirt or debris can restrict air flow and cause the engine to overheat, resulting in poor performance and reduced engine life. Continued operation with a clogged cooling system can cause severe overheating and possible engine damage. Clean these areas yearly or more often when dust or airborne debris is present (Figures 18, 19, 20).

**NOTICE:** Do not use water to clean the engine. Water could contaminate the fuel system. Use a brush or dry cloth to clean the engine.

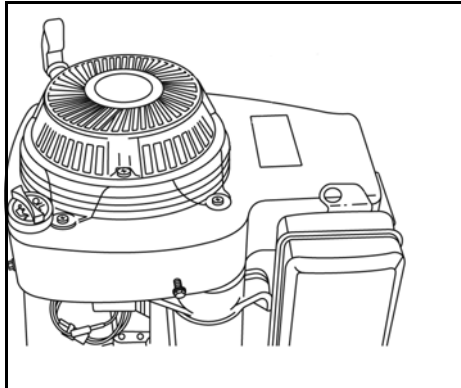


Figure 18 - Static Screen

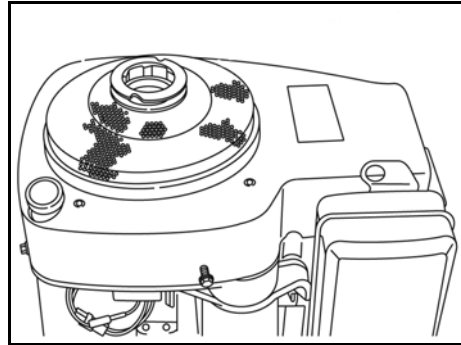


Figure 19 - Rotating Screen

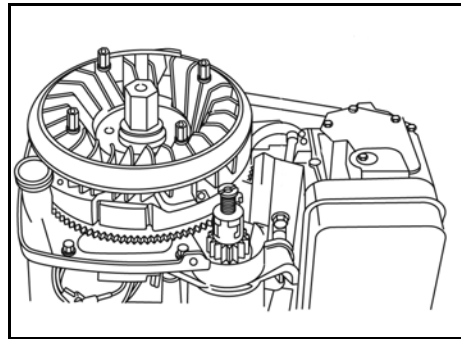


Figure 20 - Ducting & Cylinder Fins

1

## ENGINE ADJUSTMENTS

1

### Remote Control Wire Travel

The remote control wire should measure 2.125" (54 mm) when extended outside the casing (Figure 21). After installation, the travel of the remote control wire must be at least 1.375" (35 mm) to properly actuate the choke (on Choke-A-Matic® systems) and the ignition stop switch (if equipped).

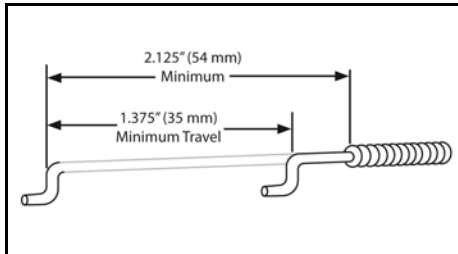


Figure 21

### Remote Controls

#### Horizontal Models 110000, 120000, 150000

1. Loosen casing clamp screw (A, Figure 22).
2. Move throttle lever to fast position.
3. Move casing in direction of arrow until slack is removed.
4. Tighten casing clamp screw.



Figure 22

#### Vertical Models 97700, 99700

1. Loosen casing clamp screw (A, Figure 23) on intake elbow assembly.

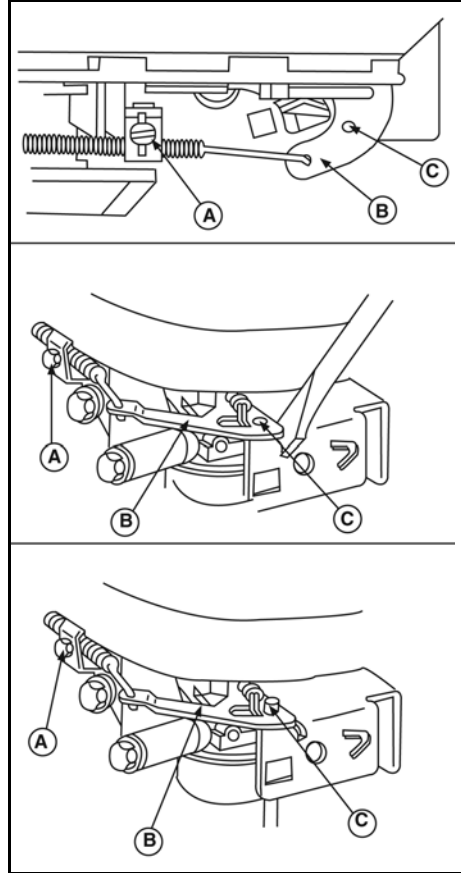


Figure 23

2. Move equipment speed control lever (B) to FAST position.
3. Move control wire and casing at governor bracket to align hole (C) in carburetor control lever with hole in carburetor control bracket.
4. Tighten casing screw.

**Vertical Models 110000, 120000 with Primer Carburetors**

1. Loosen casing clamp screw (A, Figure 24, Figure 25).
2. Move throttle lever to fast position.
3. Move casing in direction of arrow until slack is removed.
4. Tighten casing clamp screw.

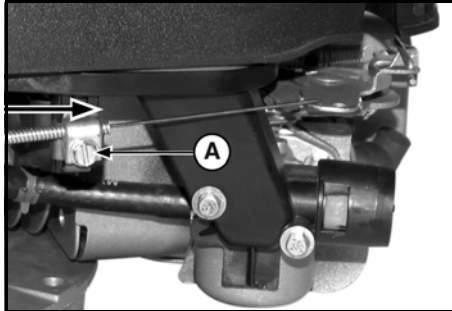


Figure 24



Figure 25

**Vertical Models Series 110000, 120000 with Choke-A-Matic® Carburetors**

1. Loosen casing clamp screw (A, Figure 26).
2. Move throttle lever to fast position.
3. Move casing in direction of arrow until casing stops moving and choke lever (B) moves to full choke position.

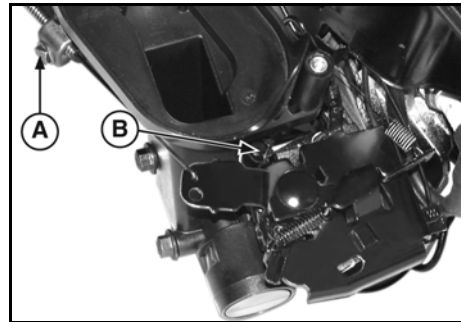


Figure 26

4. Tighten casing clamp screw.

**Horizontal and Vertical Models 200000, 210000, 280000, 310000, 330000**

1. Loosen casing clamp screw (C, Figure 27).
2. Set throttle control to FAST position.
3. Move governor control rack (D) until holes are aligned (B) between control lever (A) and the control bracket.
4. Tighten casing clamp screw.

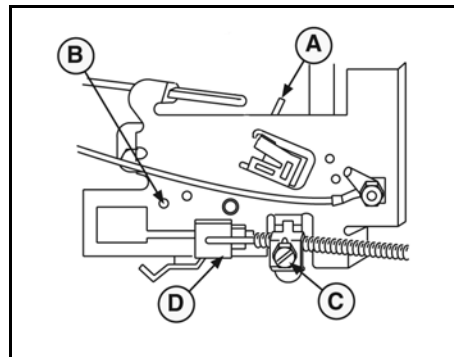


Figure 27

1

## Governor Adjustments

A complete governor system adjustment includes a static adjustment, engine warm-up, idle and/or governed idle adjustment, and top no-load adjustment. Be sure to complete all steps.

### Static Adjustment

1. Loosen screw holding governor lever to governor crank (A, Figure 28) or (C, Figure 29).
2. Rotate throttle linkage from idle position to wide open throttle. Note direction of rotation of the governor arm attached to the throttle linkage.
3. While holding linkage at wide open throttle, use the appropriate tool to rotate the governor shaft (B, Figure 29) until it stops in the direction noted in Step 2.
4. Tighten screw holding governor lever to governor crank per Section 12 - Engine Specifications.
5. Before starting engine, manually actuate throttle linkage to check for binding.

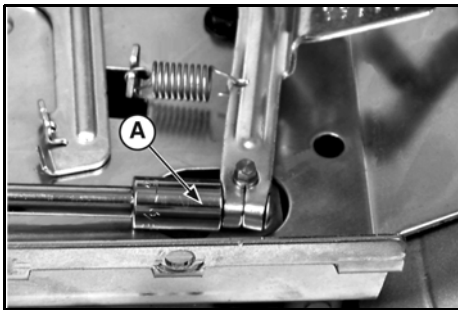


Figure 28

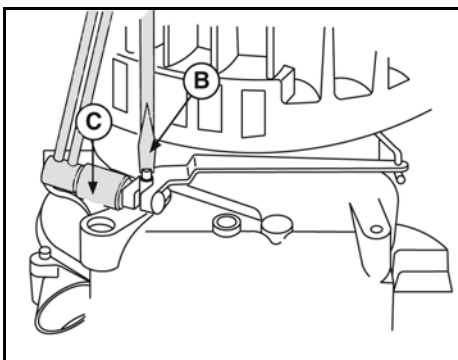


Figure 29

### Top No Load Adjustment Vertical Models 97700, 99700

1. Place throttle (A, Figure 30 and 31) in FAST position and insert a 1/8" (3.2 mm) rod (B) through holes in carburetor control bracket and lever.

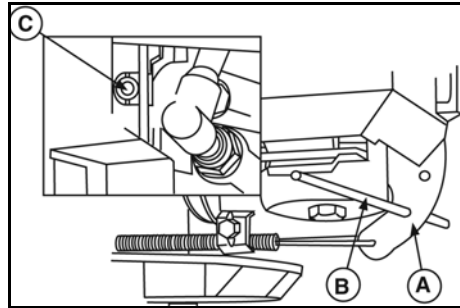


Figure 30

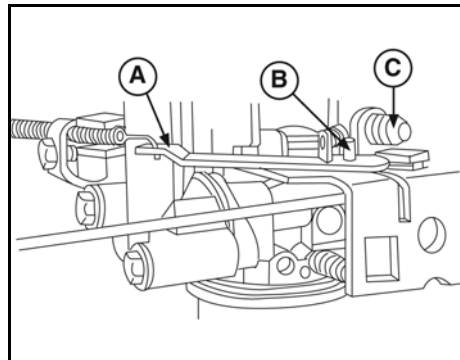


Figure 31

2. Start engine and measure RPM using Tachometer #19200 or #19389. Adjust Top No Load RPM by turning screw (C).
3. Remove 1/8" (3.2 mm) rod.

**NOTE:** Correct Top No Load RPM for each model-type-trim can be found in the engine replacement data on Briggs & Stratton websites.

**Top No Load Adjustment Vertical Models 110000, 120000, 150000 with Primer Carburetors**

1. Start engine and run until it reaches operating temperature.
2. Place throttle in FAST position.
3. Using Tachometer #19200 or #19389, and Tang Bender #19229 or #19352, bend Top No Load spring tang to obtain correct Top No Load RPM (Figure 32).

**NOTE:** Correct Top No Load RPM for each model-type-trim can be found in the engine replacement data on Briggs & Stratton websites.

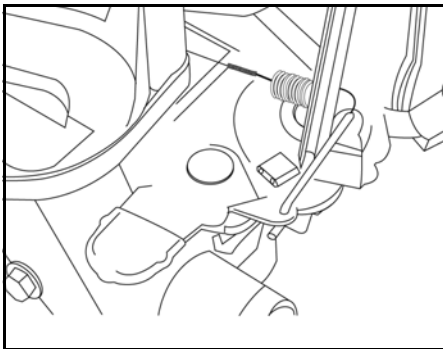


Figure 32

**Idle and Top No Load Adjustment Vertical Models 110000, 120000, 150000 with Choke-A-Matic® Carburetors**

1. Start engine and run until it reaches operating temperature.
2. Place throttle in SLOW position. Hole in lever will line up with hole in governor control bracket (Figure 33). Insert a 1/8" rod through holes to lock lever in this position.

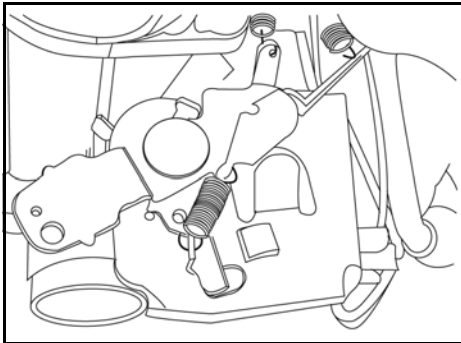


Figure 33

3. Hold throttle lever against idle speed screw and, using Tachometer #19200 or #19389, adjust to 1500 RPM. Release throttle lever.
4. Using Tang Bender #19229 or 19352 bend governed idle spring tang to obtain 1750 RPM (Figure 34).
5. Remove 1/8" rod.

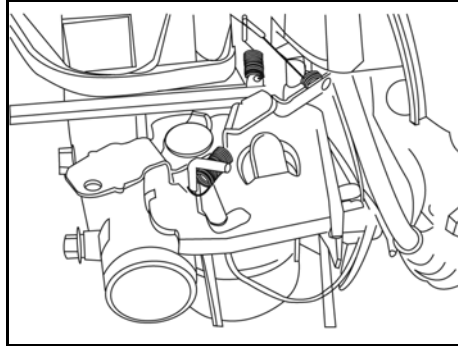


Figure 34

6. Move throttle lever to FAST position. Hole in lever will line up with hole in governor control bracket (Figure 35). Insert a 1/8" rod through holes to lock lever in this position.

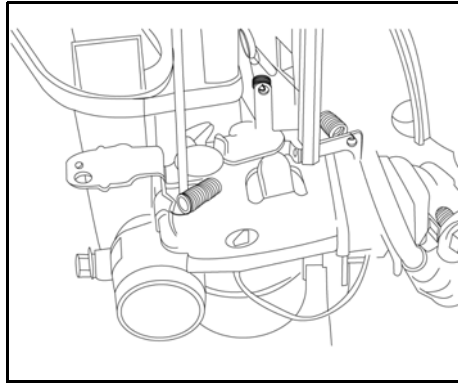


Figure 35

7. Using Tang Bender, bend Top No Load spring tang to obtain correct Top No Load RPM.

**NOTE:** Correct Top No Load RPM for each model-type-trim can be found in the engine replacement data on Briggs & Stratton websites.

1

### Idle and Top No Load Adjustment Horizontal and Vertical Models 200000, 210000

1. Start engine and run until it reaches operating temperature.
2. Place throttle in SLOW position.
3. Hold throttle lever against idle speed screw, and, using Tachometer #19200 or #19389, adjust screw to obtain 1300 RPM. Release throttle lever.
4. Using Tang Bender #19229 or #19352, bend governed idle spring tang to obtain 1750 RPM (Figure 36).

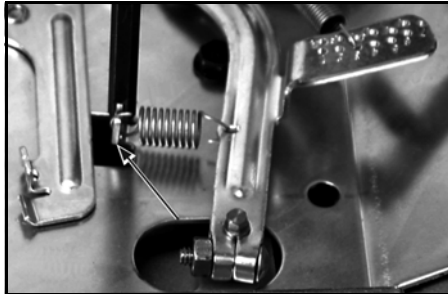


Figure 36

5. Place throttle in FAST position.
6. Adjust screw to obtain correct Top No Load RPM (Figure 37).



Figure 37

**NOTE:** Correct Top No Load RPM for each model-type-trim can be found in the engine replacement data on Briggs & Stratton websites.

### Idle and Top No Load Adjustment Vertical Models 280000, 310000, 330000

All carburetor mixture adjustments should be made before adjusting governor speeds.

1. Start engine and run until it reaches operating temperature.
2. Place control lever in idle position.
3. Hold throttle in closed position with finger, adjusting idle speed screw to 1200 RPM.
4. Release throttle.
5. Set control to 1750 RPM and bend tang (A, Figure 38) until it contacts remote control slide (B).
6. Using Tang Bender #19229 or 19352, bend spring tang to obtain the correct Top No Load RPM.

**NOTE:** Correct Top No Load RPM for each model-type-trim can be found in the engine replacement data on Briggs & Stratton websites.

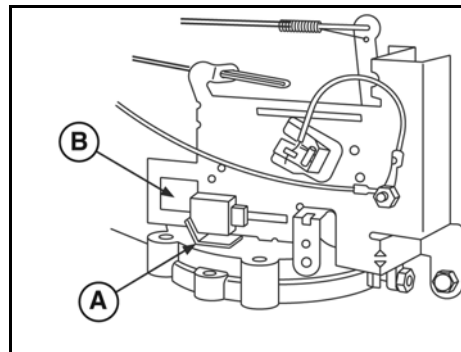


Figure 38

#### Initial Adjustment (All Models)

1. Install idle speed screws and spring. Install idle mixture screw and spring.
2. Turn idle mixture screw in until it just bottoms.
3. Then back out screw 1-1/4" turn. This will permit the engine to start.

#### Final Adjustment (All Models)

1. Install complete air cleaner before starting engine. Start and run engine for five minutes at 1/2 throttle to bring engine up to operating temperature.

2. Move equipment speed control to idle position.
3. Turn idle screw to obtain 1750 RPM minimum.
4. Then turn idle mixture screw clockwise slowly until engine begins to slow.
5. Then turn screw opposite direction until engine just begins to slow.
6. Then turn screw back to midpoint (Figure 39).

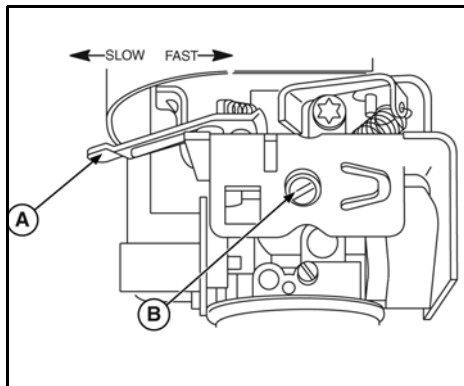


Figure 39

7. Install limiter cap (if equipped) on idle mixture screw (Figure 40).

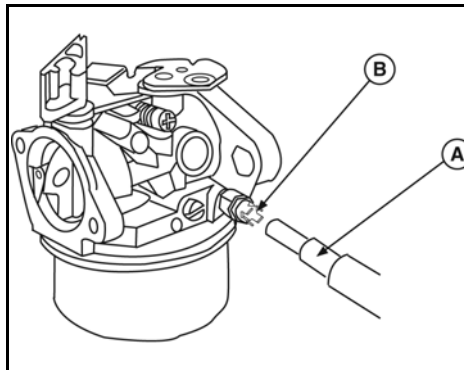


Figure 40

8. Move equipment speed control from idle to high speed position.
9. Engine should accelerate smoothly. If it doesn't, open idle mixture screw 1/8 turn open.

## Adjust Valve Clearance

**All Models - Except Vertical Models 110000, 120000 Early Production**

**NOTE:** Check valve clearance while the engine is cold.

1. Turn crankshaft counterclockwise until piston is at top dead center on the compression stroke. This prevents the compression release from holding the valves open.
2. Insert a narrow screwdriver or rod into the spark plug hole as a gauge, then slowly turn crankshaft counterclockwise until the piston has moved down the bore by 1/4" (6mm).
3. Using a feeler gauge (A, Figure 41), adjust rocker nut to obtain the clearance as listed in Section 12 - Engine Specifications.
4. Hold rocker nut and tighten the rocker ball setscrew (B) to the torque valve shown in Section 12 - Engine Specifications.
5. Check clearance again and re-adjust, if necessary.
6. Repeat for other valve.

**NOTE:** On some models, the nut and setscrew are positioned above the push rod ends.

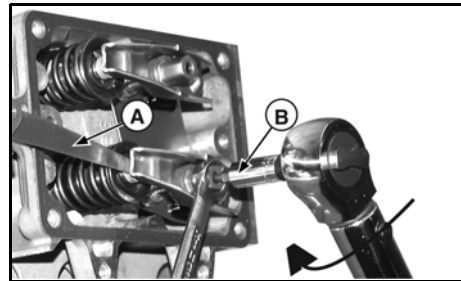


Figure 41

1



**Vertical Models 110000, 120000 Early Production**

1. Using a feeler gauge (A, Figure 42) adjust the locking hex nut (B) to obtain the correct clearance as listed in Section 12 - Engine Specifications.
2. Repeat for other valve.

1

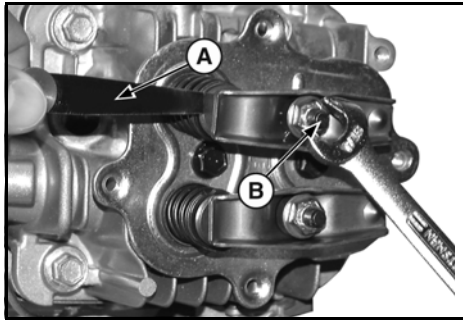


Figure 42

- OR -

1. Loosen jam nut (A, Figure 43) at base of rocker arm stud. Then, using a feeler gauge (B), turn rocker arm screw (C) to obtain the correct clearance as listed in Section 12 - Engine Specifications.
2. Hold the screw and tighten the jam nut to value shown in Section 12 - Engine Specifications.
3. Check clearance again and re-adjust, if necessary.

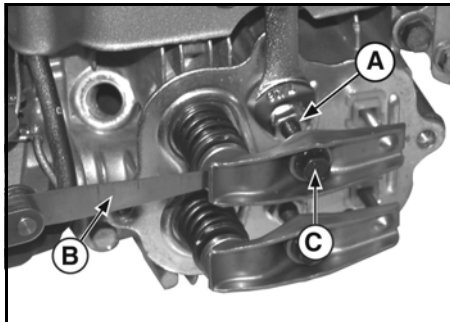
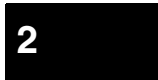


Figure 43

## SECTION 2 - TROUBLESHOOTING

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## SYSTEMS CHECK

Most complaints concerning engine operation can be classified as one or a combination of the following:

- Will not start
- Hard starting
- Lack of power
- Runs rough
- Vibration
- Overheating
- High oil consumption

The source of most of these symptoms can be determined by performing a systems check in the following order:

1. Ignition
2. Carburetion
3. Compression

This check-up can usually be done in a matter of minutes. It is the quickest and surest method of determining the cause of failure.

**NOTE:** What appears to be an engine malfunction may be a fault of the powered equipment rather than the engine. If the equipment is suspect, see Equipment Affecting Engine Operation.

### 1) Check Ignition

#### Engine Stopped

With spark plug installed, attach Ignition Tester #19368 to spark plug lead and ground the other end of the tester (Figure 1). Pull the starter rope or activate the electric starter (if equipped). If spark jumps the tester gap, you may assume the ignition system is functioning satisfactorily.



Figure 1

#### Engine Running

If engine runs but misses during operation, a quick check to determine whether the ignition is at fault can be made by installing Ignition Tester #19368 between the spark plug lead and spark plug (Figure 2). If spark is good but engine misses, install a new spark plug.

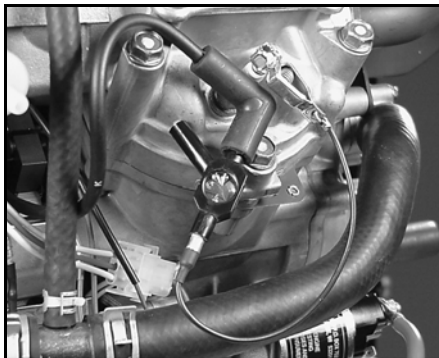


Figure 2

If spark does not occur, look for:

- Improperly operating interlock system
- Shorted equipment or engine stop switch wire
- Incorrect armature air gap
- Armature failure

## 2) Check Carburetion

Before making a carburetion check, be sure the fuel tank has an ample supply of fresh, clean gasoline.

Be sure the shutoff valve, if equipped, is open and fuel flows freely through the fuel line. If fuel fails to flow or is slow, check for plugged fuel cap vent, fuel line restriction or plugged fuel filter.

Be sure throttle and choke controls are properly adjusted.

If engine cranks but will not start, remove and inspect the spark plug.

If plug is wet, look for:

- Over choking
- Excessively rich fuel mixture
- Water in fuel
- Float needle valve stuck open
- Plugged air cleaner
- Fouled spark plug

If plug is dry, look for:

- Leaking carburetor or intake manifold gaskets
- Gummy or dirty carburetor, fuel filter, fuel lines or fuel tank
- Float needle valve stuck closed
- Inoperative fuel pump (if equipped)
- Inoperative fuel shut off solenoid (if equipped)

A simple check to determine if the fuel is getting to the combustion chamber through the carburetor is to remove the spark plug and pour a small quantity of gasoline through the spark plug hole. Replace the plug. If the engine fires a few times and then stops, look for the same conditions as for a dry plug.

### Testing Fuel Shut Off Solenoid

The fuel shut off solenoid is controlled by the equipment ignition switch. With the switch OFF, the solenoid plunger closes, stopping the fuel flow at the fixed main jet. With the switch in the ON and START positions, the solenoid plunger opens, allowing normal fuel flow. If operating properly, the solenoid will click when the switch is turned ON and OFF.

If solenoid does not click, the problem could be the equipment wiring, engine wiring or the solenoid. To determine which is the problem, perform the following tests in the order shown.

### Solenoid Plunger Test

**NOTE:** The solenoid requires a minimum of 9 Volts DC to function.

1. Remove the fuel shut off solenoid from the carburetor.
2. Place a jumper wire on either terminal of a 9 Volt battery and on one of the pins of the solenoid connector.
3. Place another jumper wire on the other pin in the solenoid connector and on the other terminal on the battery (Figure 3).

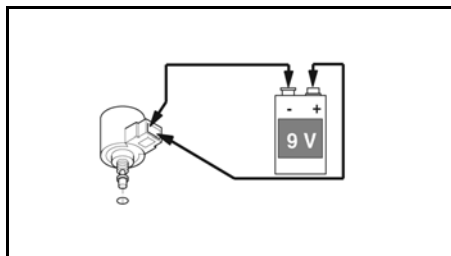


Figure 3

- Plunger should retract freely, or with very light fingertip pressure.
- When battery connection is removed, plunger should extend.
- Replace solenoid if plunger sticks or does not move.

### Solenoid Wiring Test

1. Set multimeter to DC Volts position.
2. With key switch OFF, disconnect solenoid wiring connector (A, Figure 4).
3. Attach meter test leads (B) to pins inside wiring connector.

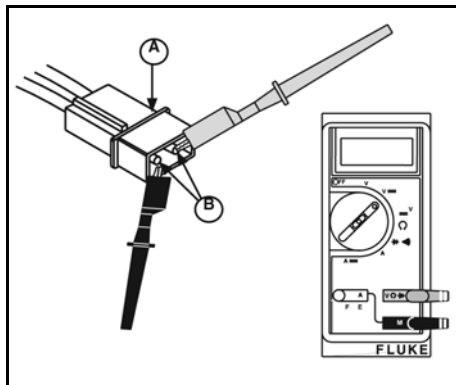


Figure 4

4. Turn key switch ON. Meter should display battery voltage.

If meter does not display battery voltage, the problem is with the solenoid wiring, equipment wire harness, or the keyswitch. Repair or replace as required.

### 3) Check Compression

Use Leakdown Tester #19545 to check the sealing capabilities of the compression components.

Follow the instructions provided with the tester to perform the leakdown test.

**NOTE:** Any air leaks at the connections or fittings of the tester will affect the accuracy of the test.

Listen for air leaking from the cylinder head gasket, carburetor, exhaust system, and the crankcase breather tube.

- Air flowing between the cylinder and cylinder head indicates that the cylinder head gasket is leaking.
- Air flowing from the carburetor indicates air is leaking past the intake valve and seat.
- Air flowing from the exhaust system indicates air is leaking past the exhaust valve and seat.
- Air flowing from the crankcase breather tube or high oil fill dipstick tube indicates air is leaking past the piston rings.

#### **Possible Causes for Poor Compression:**

- Loose cylinder head bolts
- Blown head gasket
- Burned valves, valve seats and/or loose valve seats
- Insufficient tappet clearance
- Warped cylinder head
- Warped valve stems
- Worn bore and/or rings
- Broken connecting rod

## ELECTRICAL SYSTEMS

### Equipment Used for Testing

#### Digital Multimeter

A digital multimeter is recommended for all electrical testing of Briggs & Stratton engines. The meter can be used to read volts, ohms, amperes, and to test diodes.

The Fluke® Digital Multimeter #19464 and the UNI-T® Digital Multimeter #19581 are available from your Briggs & Stratton source of supply.

**NOTICE:** The digital multimeters are equipped with fuses to prevent damage to the meter if the input limits are exceeded. Check the fuses if the meter displays a reading of **0.00** when testing DC Volts output.

Refer to the Fluke® Operator's Manual for this procedure. Replacement fuses #19449 for Series II meters or #19571 for Series III meters are available from your Briggs & Stratton source of supply.

The UNI-T® Operator's Manual lists the fuse replacement procedure and type of replacement fuses required.

#### DC Shunt

The Fluke® meter will withstand DC input of 10-20 amps for up to 30 seconds.

The UNI-T® meter will withstand DC input of 10 amps for up to 10 seconds.

When checking DC output on 10 and 16 amp regulated systems, the DC Shunt #19468 (Figure 5) is required to avoid blowing a fuse in either of the meters.

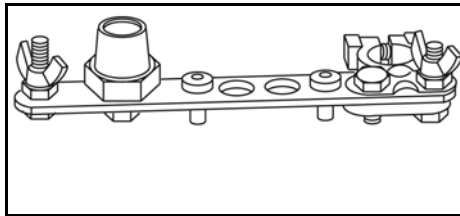


Figure 5

#### Tachometer

Tachometers #19200 (A) or #19389 (B, Figure 6) are available from your Briggs & Stratton source of supply.

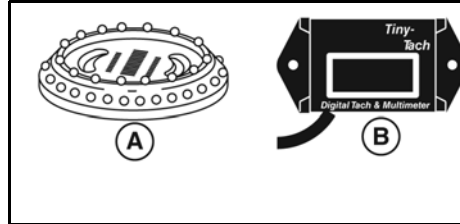


Figure 6

#### Starter Motor Test Fixture

A starter motor test fixture may be made from 1/4" (6mm) steel stock (Figure 7).

1. Extra hole for mounting starter brackets (A).
2. Drill two 3/8" (10mm) holes for starter mounting bracket (B).
3. Drill two holes for mounting Tachometer #19200. Drill and tap the holes for 1/4-20 NC screws (C).

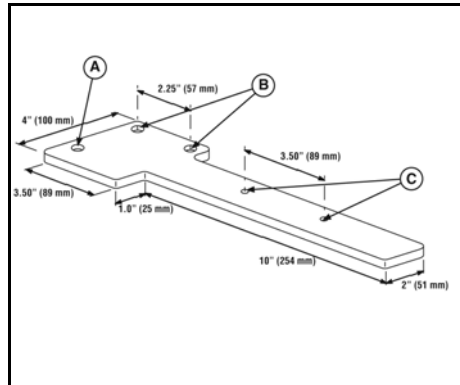


Figure 7

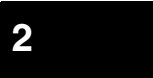
#### Other Equipment

A growler or armature tester (checks armature for continuity, shorts, and opens) is available from an Automobile Diagnostic Service supplier.

Also, a known good 12 Volt battery is required when testing starting systems or alternators.

## Alternator System Diagnosis

Complaint	Possible Causes
<b>Battery Not Charging</b>	<ul style="list-style-type: none"> <li>• Engine RPM too low.</li> <li>• Inline fuse “blown” (if equipped)</li> <li>• Defective or damaged battery (shortened battery cells)</li> <li>• Loose, pinched, or corroded battery ground leads or charge leads</li> <li>• Open, shorted, or grounded wires between output connector and battery</li> <li>• Defective diode (open or shorted)</li> <li>• Diode installed incorrectly (reversed)</li> <li>• Defective or improperly grounded regulator-rectifier</li> <li>• Excessive current draw from accessories</li> <li>• Weak or damaged alternator magnets</li> </ul>
<b>Battery Overcharged</b>	<ul style="list-style-type: none"> <li>• Severe battery vibration (missing or broken tie-down straps)</li> <li>• Battery rate of charge not matched to alternator output</li> <li>• Damaged battery (shorted battery cells)</li> <li>• Defective regulator</li> <li>• 1-Ohm resistor shorted or grounded (Tri-Circuit system only)</li> </ul>
<b>Headlamps Not Working</b>	<ul style="list-style-type: none"> <li>• Inline fuse “blown” (if equipped)</li> <li>• Defective headlamps</li> <li>• Loose or corroded wires</li> <li>• Open, shorted, or grounded wires between output connector and electric clutch</li> <li>• Light switch defective</li> <li>• Defective diode Tri-Circuit system (open or shorted – white output lead side).</li> <li>• Weak or damaged alternator magnets</li> </ul>
<b>Electric Clutch Not Working (Tri-Circuit Alternator)</b>	<ul style="list-style-type: none"> <li>• Inline fuse “blown” (if equipped)</li> <li>• Loose or corroded wires</li> <li>• Open, shorted or grounded wires between output connector and electric clutch.</li> <li>• Defective diode (open or shorted – red output lead side)</li> <li>• Defective electric clutch switch</li> <li>• Open, shorted, or grounded clutch circuit</li> <li>• Weak or damaged alternator magnets</li> </ul>





## Alternator Identification

The alternator systems installed on Briggs & Stratton OHV Engines can easily be identified by the color of the stator output wires and the connector.

2

Alternator Type	Stator Output Wire(s) Color	Connector Color	Alternator Output (at 3600 RPM *) <i>* Unless Noted</i>	Figure #
DC Only	Black	White	.5 Amp DC + Output at 2800 RPM	8
AC Only	Black	White	14 Volts AC (Lights) Unregulated	9
DC Only	Red	Red	2-4 Amps + DC (Charging) Unregulated	10
Dual Circuit	Red Black	White	2-4 Amps + DC (Charging) Unregulated 14 Volts AC (Lights) Unregulated	11
Tri-Circuit	Black	Green	5 Amps + DC (Charging) 5 Amps – DC (Lights)	12
Regulated 5 Amp	Black	Green	*1-5 Amps + DC (Charging) Regulated	13
Regulated 9 Amp	Black	Green	*1-9 Amps + DC (Charging) Regulated	13

\*Alternator output is determined by the size of the flywheel alternator magnets.

### 1. 0.5 Amp DC Only (Figure 8)

- Unregulated
- Output at 2800 RPM
- .5 Amps DC for charging battery
- One black lead (A) from stator
- White connector (B) output lead

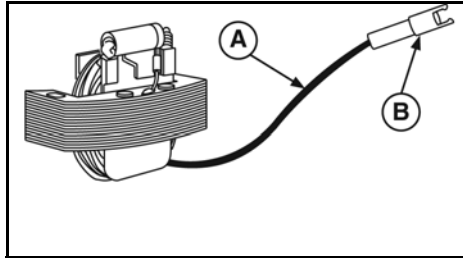


Figure 8

### 2. 14 Volt AC Only (Figure 9)

- 14 Volts AC for lighting circuit
- One black lead from stator (A)
- White connector (B) output lead
- Unregulated

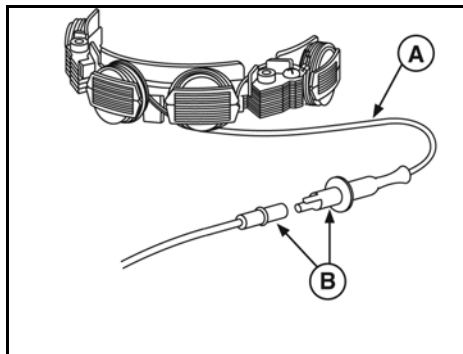


Figure 9

### 3. 3 Amp DC Only (Figure 10)

- 3 Amps DC unregulated for charging battery
- One red lead (A) from stator
- Diode encased at connector
- Red connector (B) output lead

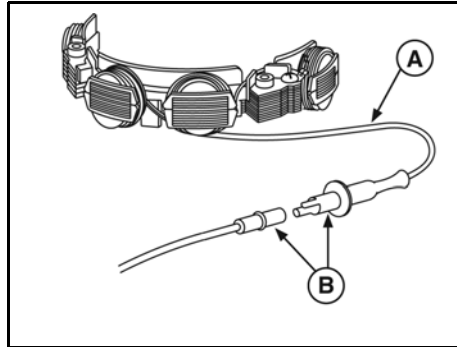


Figure 10

### 4. Dual Circuit (Figure 11)

- 3 Amps DC unregulated for charging battery, red lead from stator (A)
- 14 Volts AC for lighting circuit, black lead from stator (B)
- Diode encased at connector
- White connector (E) with two pin terminals
- White lead (D), AC current for lights
- Red lead (C), DC current for charging circuit

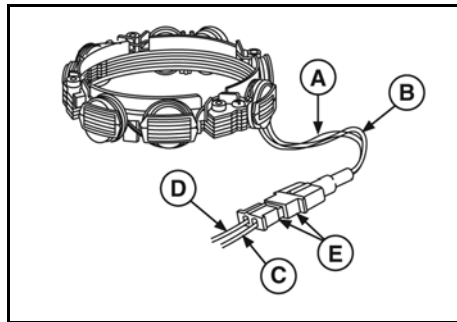


Figure 11

### 5. Tri-Circuit (Figure 12)

- Stator assembly (A)
- Black lead from stator (B)
- Connector (C)
- Two diodes encased in wiring harness (D)
- WHITE lead - 5 Amps DC (-) to lights (E)
- RED lead - 5 Amps DC (+) to battery, clutch (F)

2

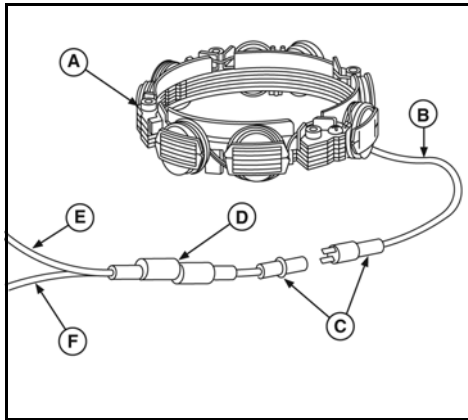


Figure 12

**6. 5/9 Amp DC (Figure 13)**

- 5 or 9 Amp DC based on size of flywheel magnet
- 5 - 9 Amps DC regulated for charging battery
- One black lead from stator (A)
- Green connector (B)
- Yellow lead (C) to regulator-rectifier (F)
- One lead (D) from regulator-rectifier with red connector (E)

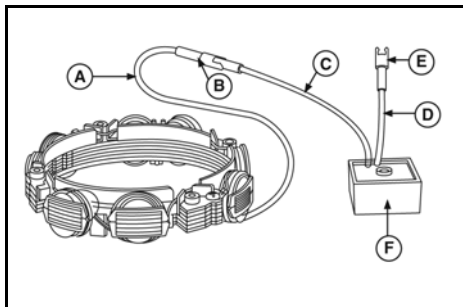


Figure 13

**7. 10/16 Amp DC (Figure 14)**

- 10 or 16 Amps DC regulated for charging battery
- Two black leads (C) from stator
- Yellow connector (D) with two pin terminals
- Two yellow leads (E) to regulator-rectifier (F)

- One red lead (B) from regulator-rectifier to red connector output lead (A)
- 10 and 16 Amp systems use the same stator, color coding and regulator-rectifier
- Alternator output is determined by the flywheel alternator magnet size

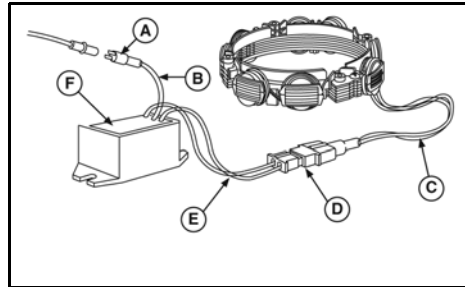


Figure 14

**8. 20 Amp DC (Figure 15)**

- 20 Amps DC regulated for charging battery
- Two yellow leads from stator (A)
- Red output lead from connector (B)
- Connector (C)
- Two yellow AC input leads (D)
- Regulator Rectifier (E)
- Red output lead from regulator-rectifier (F)

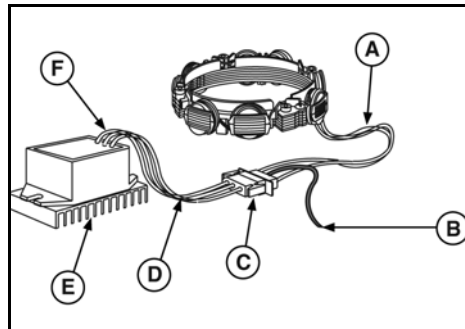


Figure 15

### Flywheel Identification

OHV single cylinder flywheels have a single ring of magnets which provide the magnetic field for the various alternator systems, except Model Series 97700, 99700, 121600, 126000 which use the magneto magnet. There are two sizes of flywheel magnets. The size of the magnet determines alternator output.

The following table identifies the magnet size to be used with a specific alternator system.

**NOTICE:** Do not use large-magnet flywheels with AC-only, DC-only, or Dual Circuit Alternators.

- Small Magnet - Approx. 28/32" x 21/32" (22mm x 17mm).
- Large Magnet - Approx. 1-3/32" x 29/32" (28mm x 23mm).

### Testing Alternator Output

The following alternator test procedures were developed using the Fluke® Digital Multimeter. When performing alternator tests with the UNI-T® Digital Multimeter, refer to the operating manual supplied with that meter for the proper procedure.

All test values will be the same regardless the meter used.

**NOTE:** Before testing alternator output, use an accurate tachometer to temporarily adjust the engine speed to the RPM specified in the test instructions.

When testing alternators, perform the tests in the following sequence:

1. Test alternator output.
2. Test diode(s) or regulator-rectifier (if equipped).

### .5 Amp DC Only Alternator

The .5 Amp, DC alternator is designed to operate as an integral part of the engine and is separate from the starting and ignition system. It is intended to provide DC charging current for a 12 Volt battery. Contact battery or equipment manufacturer for battery information.

#### Test Alternator Output

Disconnect charging lead to battery at connector.

1. Insert RED test lead into 10 Amp receptacle in meter.
2. Insert BLACK test lead into COM receptacle in meter.
3. Rotate selector to DC Amps position.
4. Attach RED test clip to output terminal (A, Figure 16).
5. Attach BLACK test clip to charging lead (B) that was disconnected at the connector.

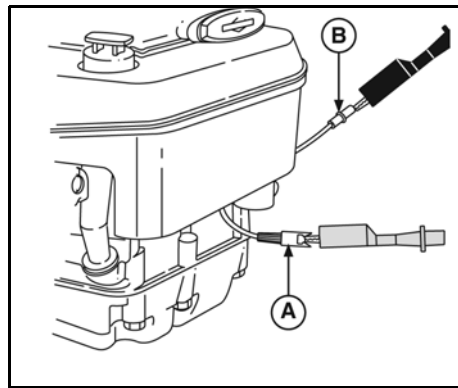


Figure 16

6. With engine running at 2800 RPM, output should be no less than .5 Amp DC.
7. If low or no output, check stator air gap.
8. If stator air gap is within specification and there is low or no output, replace stator.

### 3-Amp DC Only Alternator

The DC alternator provides DC current for charging a 12 Volt battery. Current from the alternator is unregulated and is rated at 3 Amps. The output rises from 2 Amps at 2400 RPM to 3 Amps at 3600 RPM.

#### Test Alternator Output

1. Insert RED test lead (A, Figure 17) into 10 Amp receptacle in meter.
2. Insert BLACK test lead (B) into COM receptacle in meter.
3. Rotate selector to DC Amps position.
4. Attach RED test lead clip to DC output terminal connector (C).

- Attach BLACK test lead clip to positive (+) battery terminal.

**NOTE:** Negative (-) battery terminal must be grounded.

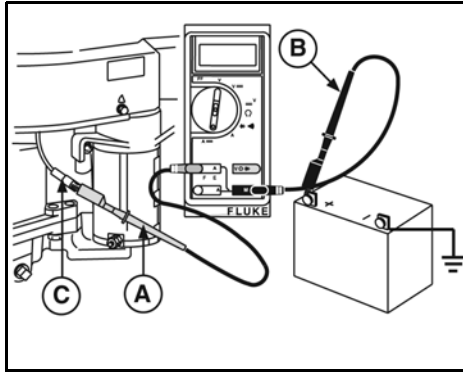


Figure 17

- With engine running at 3600 RPM, output should be between 2 to 4 Amps DC.
  - Output will vary with battery voltage. If battery voltage is at its maximum, output will be approximately 2 Amps.
- If no or low output is found, test diode.

#### Test Diode

In the Diode Test position, the meter will display forward voltage drop across the diode(s). If voltage drop is less than 0.7 volts, meter will "Beep" once as well as display voltage drop. A continuous tone indicates continuity (shorted diode). An incomplete circuit (open diode) will be displayed as "OL."

- Insert RED test lead (A, Figure 18) into the V  $\Omega$  receptacle and set the rotary switch to Diode position.
- Insert BLACK test lead (B) into the COM receptacle in the meter.
- Attach RED test lead clip to (C) and Black test lead clip to point (D). (It may be necessary to pierce wire with a pin as shown.)

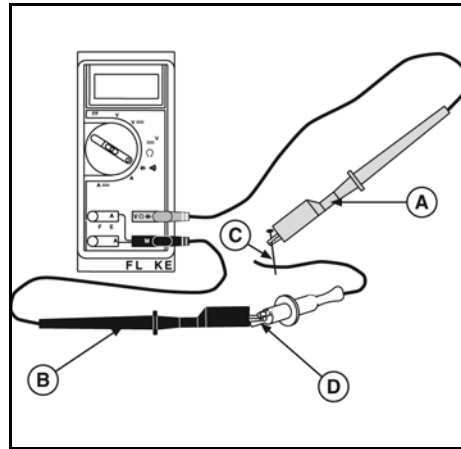


Figure 18

- If meter "Beeps" once, diode is OK.
  - If meter makes a continuous tone, diode is defective (shorted).
  - If meter displays "OL," proceed to Step 4.
- Reverse test leads.
    - If meter "Beeps" once, diode is installed backwards.
    - If meter still displays "OL," diode is defective (open).
  - If diode tests OK, replace stator.

**NOTE:** Service replacement diode harnesses are available. Use Rosin Core solder when installing new harness. Use shrink tubing or tape for all connections. Do not use crimp connectors.

#### 14-Volt AC Alternator

The AC alternator provides current for headlights only. Current for the lights is available when the engine is running. To check, use 12 Volt lights with a total rating of 60-100 watts. Alternator output varies with engine speed. With lights rated at 70 watts, the voltage rises from 8 Volts @ 2400 RPM to 12 Volts @ 3600 RPM. The lights should become brighter as the engine speed increases.

### Test Alternator Output

1. Insert RED test lead (A, Figure 19) into the V  $\Omega$  receptacle in the meter.
2. Insert BLACK test lead (B) into COM receptacle.
3. Rotate selector to AC Volts position.
4. Attach RED test lead clip to AC output terminal (C).
5. Attach BLACK test lead clip to engine ground.

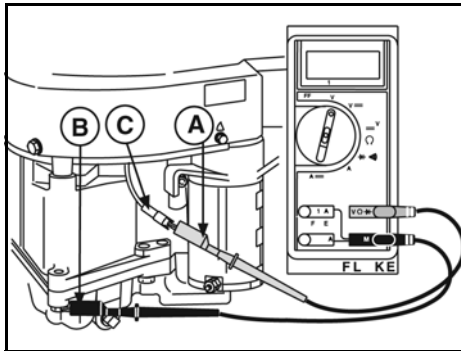


Figure 19

6. With engine running at 3600 RPM, AC output should be no less than 14 Volts.
  - If NO or LOW output is found, replace the stator.

### Dual Circuit Alternator

Dual Circuit alternators use a polarized plug with two pins. One pin provides DC current for charging the battery, the second pin is an independent AC circuit for headlights.

Current for lights is available when the engine is running. The output varies, so brightness of the lights changes with engine speed. 12 Volt lights with a total rating of 60 to 100 watts may be used. With lights rated at 70 watts, the voltage rises from 8 Volts @ 2400 RPM to 12 Volts at 3600 RPM. Since the battery is not used for the lights, the lights are available even if the battery is disconnected or removed.

Current for the DC side of the alternator is unregulated and is rated at 3 Amps. The output rises from 2 Amps @ 2400 RPM to 3 Amps @ 3600 RPM.

### Test Alternator Output-AC

1. Insert RED test lead (A, Figure 20) into the V  $\Omega$  receptacle in the meter.
2. Insert BLACK test lead (B) into COM receptacle.
3. Rotate selector to AC Volts position.
4. Attach RED test lead clip to AC output pin (C).
5. Attach BLACK test lead clip to engine ground.

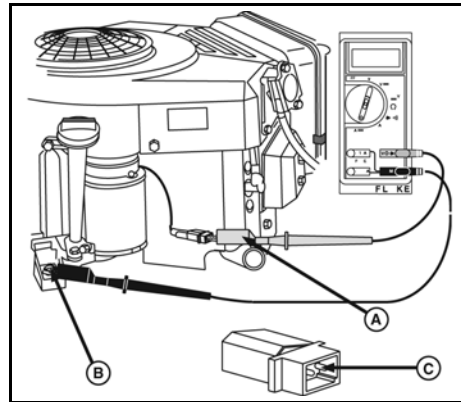


Figure 20

6. With engine running at 3600 RPM, AC output should be no less than 14 Volts.
  - If NO or LOW output is found, replace the stator.

### Test Alternator Output-DC

**NOTE:** The battery MUST be in good condition to perform this test.

1. Insert RED test lead into 10 Amp receptacle in meter.
2. Insert BLACK test lead into COM receptacle in meter.
3. Rotate selector to DC Amps position.
4. Attach RED test lead clip (A, Figure 21) to DC output pin (F) in connector (D).

**NOTE:** The raised rib on the connector or the RED wire indicates the DC output pin side. The AC pin is not used for the test.

5. Attach BLACK test lead clip (B) to the positive (+) battery terminal.

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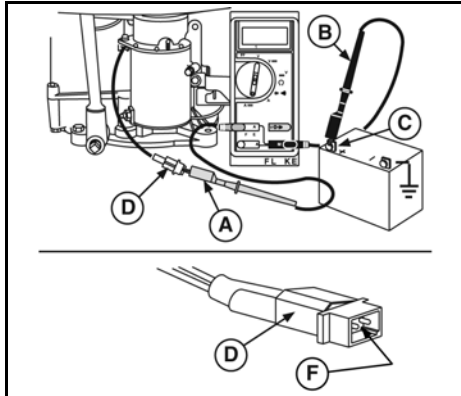


Figure 21

6. With the engine running at 3600 RPM, output should be between 2 - 4 Amps DC.

**NOTE:** The output will vary with the battery voltage. At maximum battery voltage the output will be approximately 2 Amps.

7. If NO or LOW output is found, test diode.

#### Test Diode

In the Diode Test position, the meter will display forward voltage drop across the diode(s). If voltage drop is less than 0.7 volts, meter will "Beep" once as well as display voltage drop. A continuous tone indicates continuity (shorted diode). An incomplete circuit (open diode) will be displayed as "OL."

1. Insert RED test lead (A, Figure 22) into the V  $\Omega$  receptacle and set the rotary switch to Diode position.
2. Insert BLACK test lead (B) into the COM receptacle in the meter.
3. Attach RED test lead clip to point (C) and Black test lead clip to point (D). (It may be necessary to pierce wire with a pin as shown.)

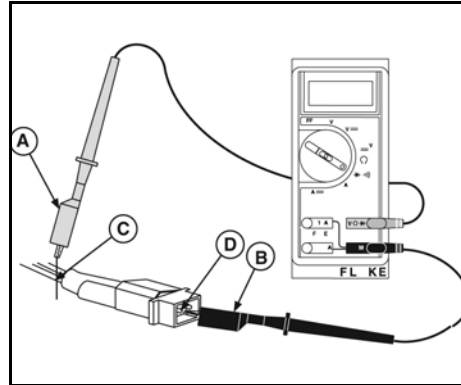


Figure 22

- If meter "Beeps" once, diode is OK.
  - If meter makes a continuous tone, diode is defective (shorted).
  - If meter displays "OL," proceed to Step 4.
4. Reverse test leads.
    - If meter "Beeps" once, diode is installed backwards.
    - If meter still displays "OL," diode is defective (open).
  5. If diode tests OK, replace stator.

**NOTE:** Service replacement diode harnesses are available. Use Rosin Core solder when installing new harness. Use shrink tubing or tape for all connections. Do not use crimp connectors.

#### Tri-Circuit Alternator

The tri-circuit alternator provides alternating current (AC) through a single output lead and connector to a wiring harness containing two diodes.

One diode rectifies the AC current to 5 Amps negative (-) DC for lights. The second diode rectifies the AC current to 5 Amps positive (+) DC for battery charging and external loads, such as an electric clutch.

**NOTE:** Some original equipment manufacturers (OEMs) supply diodes as an integral part of the equipment wiring harness. Some OEMs use a 1 Ohm-20 Watt resistor placed in series with (+) DC charging lead, limiting the charging current to approximately 3 Amps when the clutch is not engaged. When the clutch is engaged, the

resistor is bypassed allowing full output to the battery and clutch.

The battery is not used for the lights, so lights are available even if the battery is disconnected or removed. Current for the lights is available when the engine is running. The output varies, so the brightness of the lights changes with engine speed.

#### Test Alternator Output

1. Insert RED test lead (A, Figure 23) into the V  $\Omega$  receptacle in the meter.
2. Insert BLACK test lead (B) into COM receptacle in the meter.
3. Rotate selector to AC Volts position.
4. Attach RED test lead clip to AC output terminal (C).
5. Attach BLACK test lead clip to engine ground.

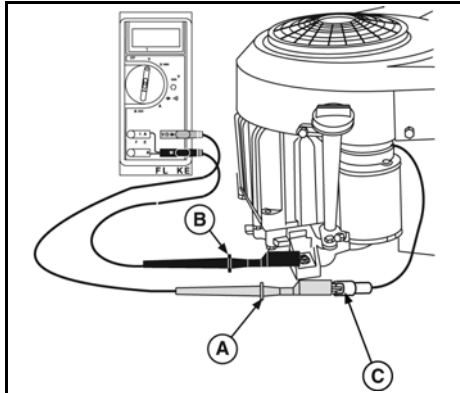


Figure 23

6. With engine running at 3600 RPM, AC output should be no less than 28 Volts.
  - If NO or LOW output is found, replace the stator.
  - If alternator output is good, test the diodes in the wiring harness.

#### Test Diode

One diode is for the charging circuit, the other diode is for the lighting circuit.

In the Diode Test position, the meter will display forward voltage drop across the diode(s). If voltage drop is less than 0.7 volts, meter will

“Beep” once as well as display voltage drop. A continuous tone indicates continuity (shorted diode). An incomplete circuit (open diode) will be displayed as “OL.”

#### Charging Circuit Test (RED Wire)

1. Insert RED test lead (A, Figure 24) into the V  $\Omega$  receptacle and set the rotary switch to Diode position.
2. Insert BLACK test lead (B) into the COM receptacle in the meter.
3. Attach BLACK test lead clip to (C) of the RED wire (D). (It may be necessary to pierce wire with a pin as shown.)
4. Insert RED test lead (A) into harness connector.

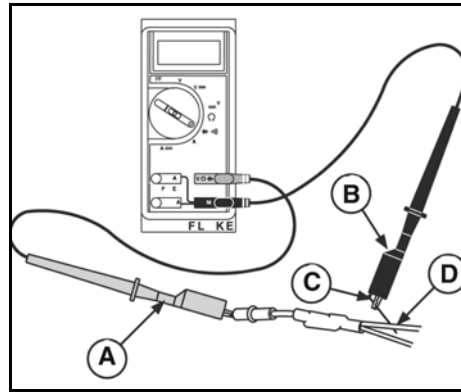


Figure 24

- If meter “Beeps” once, diode is OK.
  - If meter makes a continuous tone, diode is defective (shorted).
  - If meter displays “OL,” proceed to Step 4.
5. Reverse test leads.
    - If meter “Beeps” once, diode is installed backwards.
    - If meter still displays “OL,” diode is defective (open).
  6. If diode tests OK, replace stator.

#### Lighting Circuit Test (WHITE Wire)

1. Insert RED test lead (A, Figure 25) into the V  $\Omega$  receptacle and set the rotary switch to Diode position.



2. Insert BLACK test lead (B) into the COM receptacle in the meter.
3. Attach RED test lead clip to (D) of the WHITE wire (C). (It may be necessary to pierce wire with a pin as shown.)
4. Insert BLACK test lead (B) into harness connector.

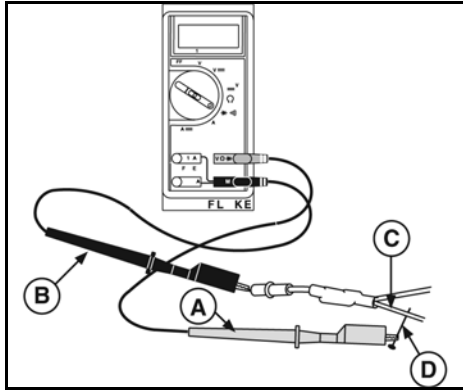


Figure 25

- If meter “Beeps” once, diode is OK.
  - If meter makes a continuous tone, diode is defective (shorted).
  - If meter displays “OL,” proceed to Step 4.
5. Reverse test leads.
    - If meter “Beeps” once, diode is installed backwards.
    - If meter still displays “OL,” diode is defective (open).
  6. If diode tests OK, replace stator.

### 5 & 9 Amp DC Regulated Alternator

The 5 & 9 Amp regulated alternator systems provide AC current through a single lead into the regulator-rectifier. The regulator-rectifier converts the AC current to DC and regulates current to the battery. The charging rate will vary with engine RPM and temperature.

Alternator output is determined by the flywheel alternator magnet size. The stator and regulator-rectifier are the same for the 5 & 9 Amp regulated system and the Tri-Circuit System.

### Test Alternator Output

1. Temporarily disconnect stator wire harness from the regulator-rectifier.
2. Insert RED test lead (A, Figure 26) into the V  $\Omega$  receptacle in the meter.
3. Insert BLACK test lead (B) into COM receptacle.
4. Rotate selector to AC Volts position.
5. Attach RED test lead clip to GREEN output terminal (C).
6. Attach BLACK test lead clip to engine ground.

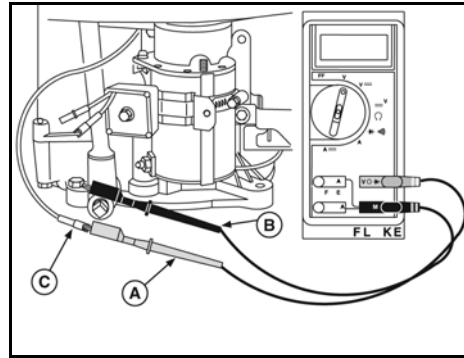


Figure 26

7. With engine running at 3600 RPM, AC output should be no less than:
  - 28 Volts AC - 5 Amp System
  - 40 Volts AC - 9 Amp System
8. If NO or LOW output is found, replace the stator.

### Test Regulator-Rectifier

**NOTE:** The regulator-rectifier will not function unless it is grounded to engine. Make sure the regulator-rectifier is securely mounted to the engine. When testing regulator-rectifier amperage output, a 12 Volt battery with a minimum charge of 5 Volts is required. There will be no output if battery voltage is below 5 Volts.

**NOTICE:** Connect test leads BEFORE starting the engine. Be sure connections are secure. If a test lead vibrates loose while engine is running, the regulator-rectifier may be damaged.

1. Connect stator wire harness to regulator-rectifier.
2. Insert RED test lead into 10 Amp receptacle in meter.
3. Insert BLACK test lead into COM receptacle in meter.
4. Rotate selector to DC Amps position.
5. Attach RED test lead clip (A, Figure 27) to RED DC output terminal on regulator-rectifier.
6. Attach BLACK test lead clip (B) to positive (+) battery terminal.

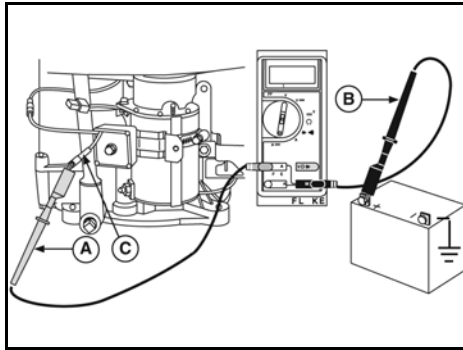


Figure 27

7. Run the engine at 3600 RPM. The output should be:
  - 3-5 Amps - 5 Amp System
  - 3-9 Amps - 9 Amp System

**NOTE:** The amperage produced depends on the battery voltage. If the battery is below 11 Volts, the output reading would be 5 or 9 Amps, depending upon the alternator system being tested. The amperage will be less at maximum battery voltage.

8. If NO or LOW output is found, be sure that the regulator-rectifier is grounded properly and all connections are clean and secure. If there is still NO or LOW output, replace the regulator-rectifier.

### 10 & 16 Amp DC Regulated Alternator

The 10 & 16 Amp regulated alternator system provides AC current through two YELLOW output leads to the regulator-rectifier. The regulator-rectifier converts the AC current to DC and regulates current to the battery. The charging rate varies with engine RPM and temperature.

The stator and regulator-rectifier are the same for the 10 and 16 Amp systems. The system output is determined by the flywheel magnet size.

### Test Alternator Output

1. Temporarily disconnect stator wire harness from the regulator-rectifier.
2. Insert RED test lead (A, Figure 28) into the V  $\Omega$  receptacle in the meter.
3. Insert BLACK test lead (B) into COM receptacle.
4. Rotate selector to AC Volts position.
5. Insert RED (A) and BLACK (B) test lead probes into output terminals (D & E) in YELLOW connector (C). (Test clip leads may be attached to either terminal).
6. With the engine running at 3600 rpm, the output should be no less than:
  - 20 volts - 10 Amp System
  - 30 volts - 16 Amp System
7. If No or Low output is found, check for bare wires or other defects. If wiring defects are not found, replace the stator.

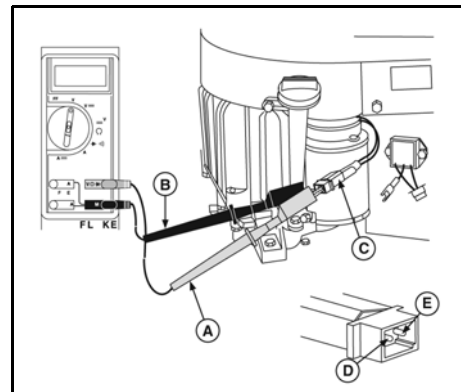


Figure 28

### Test Regulator - Rectifier

**NOTE:** The regulator-rectifier will not function unless it is grounded to engine. Make sure the regulator-rectifier is securely mounted to the engine. When testing regulator-rectifier amperage output, a 12 Volt battery with a minimum charge of 5 Volts is required. There will be no output if battery voltage is below 5 Volts.

**NOTICE:** Connect test leads BEFORE starting the engine. Be sure connections are secure. If a test lead vibrates loose while engine is running, the regulator-rectifier may be damaged.

Use the DC Shunt #19468 (D, Figure 29) to avoid blowing the fuse in the test meter when testing the DC output of the 16 Amp system. The DC Shunt must be installed to the negative (-) terminal of the battery. All connections must be clean and tight to obtain accurate readings.

1. Connect stator wire harness to regulator-rectifier.
2. Install shunt to negative (-) battery terminal.
3. Insert RED test lead (A) into V  $\Omega$  receptacle in meter. Connect to RED post terminal (C) on shunt.
4. Insert BLACK test lead (B) into COM receptacle in meter and connect to BLACK post terminal (E) on shunt.
5. Rotate selector to 300mV position.

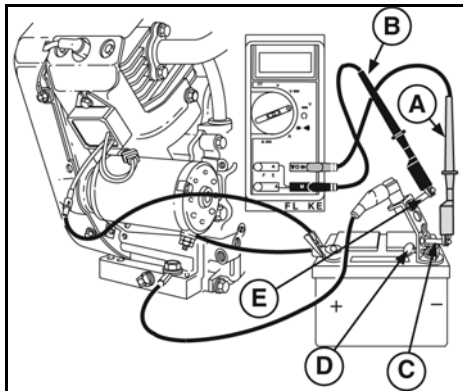


Figure 29

6. Run the engine at 3600 RPM. The output should be:
  - 3-10 Amps - 10 Amp System
  - 3-16 Amps - 16 Amp System

**NOTE:** The amperage produced depends on the battery voltage. If the battery is below 11 Volts, the output reading would be 10 or 16 Amps, depending upon the alternator system being tested. The amperage will be less at maximum battery voltage.

7. If NO or LOW output is found, be sure that the regulator-rectifier is grounded properly

and all connections are clean and secure. If there is still NO or LOW output, replace the regulator-rectifier.

#### Regulator-Rectifier with Charge Indicator

The regulator-rectifier #493219 is used by OEMs that have a charging indicator light instead of an ammeter. In addition to the RED DC output wire (A, Figure 30), the regulator-rectifier has a blue wire (B) to activate a charging indicator light when battery voltage is below 12 volts. The connector has a raised rib (C) on the red wire side to indicate the output side of the connector.

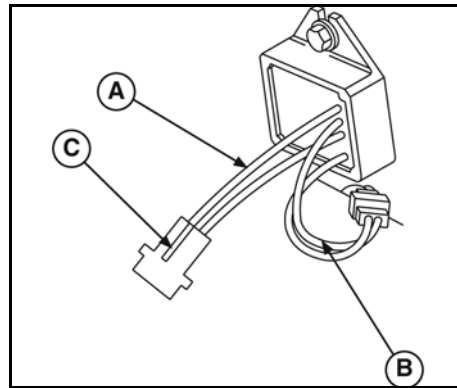


Figure 30

The charging indicator light should light when the key switch in ON and the engine not running. With the engine running, the charging indicator light should go out, indicating that the charging circuit is operating and the battery voltage in above 12 volts.

The charge indicator light and wiring is supplied by the OEM.

DC charging output values and test procedures are the same as those listed for the 10 amp and 16 amp systems.

### 20 Amp DC Regulated Alternator

The 20 Amp regulated alternator system provides AC current through two output leads to the regulator-rectifier. The regulator-rectifier converts the AC current to DC, and regulates current to the battery. The charging rate will vary with engine RPM and temperature.

#### Test Alternator Output

1. Temporarily disconnect stator wire harness from regulator-rectifier.
2. Insert RED test lead into V  $\Omega$  receptacle in meter.
3. Insert BLACK test lead into COM receptacle.
4. Rotate selector to AC Volts position.

**NOTICE**

**Attach meter test leads to the AC output terminals (yellow wires) in the connector BEFORE starting the engine. If the stator is grounded (defective) and the meter test leads contact the center DC output pin (red wire) in the connector, arcing could occur, damaging the wire.**

5. Attach red (A, Figure 31) and black (B) test lead probes to the yellow wire (C) AC output terminals (D), of the connector (F).

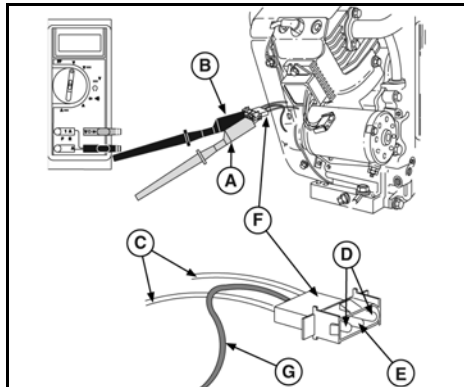


Figure 31

6. If No or Low output is found, check for bare wires or other defects. If shorted leads are not visible, replace the stator.
7. With the engine running at 3600 rpm, output should be no less than 26 volts.

### DC Output Charging Wire Test

A simple test can be used to test the DC output charging wire circuit. If a wiring problem exists, it can be corrected before testing the regulator-rectifier.

1. Leave stator wire harness disconnected from the regulator-rectifier.
2. Equipment key switch must be in OFF position.
3. Insert RED test lead into V  $\Omega$  receptacle in meter.
4. Insert BLACK test lead into COM receptacle.
5. Rotate selector to DC Volts position.
6. Attach red test lead probe (A, Figure 31) to the red wire (G) DC output terminal (E) of the connector.
7. Attach black test lead probe (B) to negative battery terminal.
8. Turn equipment key switch to ON position. Meter should display Battery Voltage.
9. If meter does not display battery voltage, check for blown fuse or broken or shorted wires.

### Regulator-Rectifier Test

The DC Shunt #19359 must be installed on the negative (-) battery terminal to avoid blowing the fuse in the meter when testing the output of the 20 amp system. All connections must be clean and tight for correct readings.

1. Connect stator wire harness to regulator-rectifier.
2. Install DC Shunt #19359 (D, Figure 32) on negative (-) battery terminal.
3. Insert RED test lead (A) into V  $\Omega$  receptacle in meter and connect to red post terminal on shunt (E).
4. Insert BLACK test lead (B) into COM receptacle in meter and connect to black post on shunt (C).

2

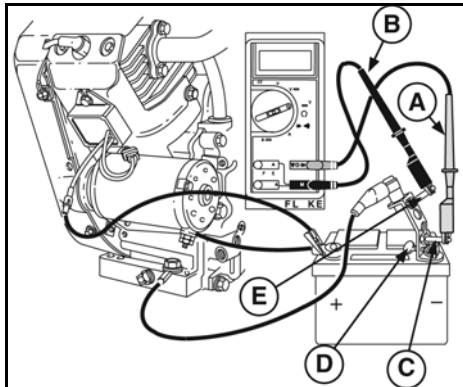


Figure 32

5. Rotate selector to DC volts position.
6. With the engine running at 3600 rpm, the output should be 3-20 amps.
7. If no or low output is found, be sure that the regulator-rectifier is grounded properly and all equipment connections are clean and secure. If there is still no or low output, replace the regulator-rectifier.

## ELECTRIC STARTERS

Before assuming an electric starter requires service, check the engine for freedom of rotation by removing the spark plug and turning the crankshaft over by hand. Any belt, clutch, or other parasitic load will affect the starter cranking performance, so ensure their effects are minimized.

The following list is given to aid in diagnosing problems for 12 Volt and 120 Volt starting systems.

1. Engine Cranks Slowly
  - Parasitic load affecting performance
  - Discharged, defective, or incorrect battery (also, see alternators)
  - Faulty electrical connection (battery circuit)
  - Dirty or worn starter motor commutator, bearing, weak magnets, etc.
  - Wrong engine oil viscosity for ambient temperatures
  - Defective starter clutch
  - Band brake misadjusted
  - Battery leads too long or wire diameter too small
  - Extension cord longer than 25 feet (7.60 mm) (120 volt AC only)
2. Engine Will Not Crank
  - Faulty safety interlocks
  - Discharged or defective battery
  - Faulty electrical connections
  - Faulty starter motor switch (open circuit)
  - Open circuit in starter motor
  - Defective rectifier assembly (120 Volt AC only)
  - Brushes sticking, etc.
  - Faulty solenoid
  - Blown fuse or tripped breaker at power source.
3. Starter Motor Spins But Does Not Crank Engine
  - Sticking pinion gear
  - Damaged pinion or ring gear
  - Starter motor clutch slipping
  - Incorrect rotation due to reversed motor polarity (all motors rotate counterclockwise, as viewed from pinion gear)
4. Starter Motor Blows Fuses - (120 Volt Starter Motor Only)
  - Parasitic load
  - Shorted rectifier assembly
  - Shorted 120 volt extension cord to starter motor
  - Armature shorted
  - Overloaded circuit
5. Starter Motor Spins But Will Not Stop
  - Defective starter switch
  - Defective solenoid

### SYSTEM 3®, SYSTEM 4®

#### Model Series 97700, 99700, 110000, 120000

Both of these systems consist of a starter motor (A, Figure 33), starter switch, interlock switch (B), and solenoid (optional). When the starter switch or solenoid is actuated, the battery supplies power to the starter motor, cranking the engine. When the engine is running, the alternator (C) recharges the battery.

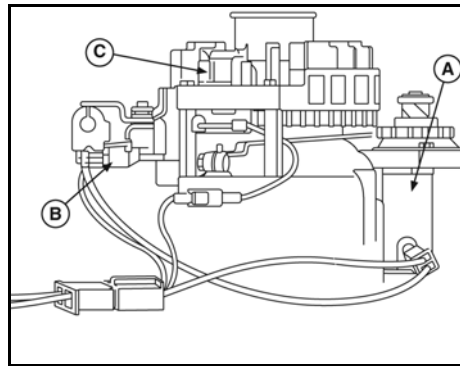


Figure 33

#### Check Starter Motor Drive and Clutch

When starter switch is activated, pinion gear (A, Figure 34) should rise, engage flywheel ring gear, and crank engine. The pinion gear must rotate counterclockwise, as viewed from gear.

If starter motor drive does not react properly, check helix (B) and pinion gear for free operation.

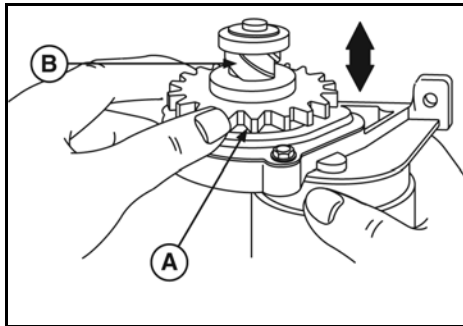


Figure 34

If the pinion gear sticks, clean the helix and gear with a mild solvent and compressed air. If the pinion continues to stick, replace the entire starter drive assembly.

**NOTE:** Do not oil the pinion gear or helix.

The starter motor clutch is designed to prevent damage from shock loads such as engine backfire. If clutch slips while cranking, replace the entire starter drive assembly.

#### Test Starter Motor

1. Clamp starter motor test fixture in vise.
2. Remove starter motor from engine and mount to fixture (Figure 35).

**NOTICE:** Do not clamp motor housing in a vise or strike with a hammer. Most starter motors contain ceramic magnets that can be damaged if the motor housing is hit, deformed, or dented.

3. Set meter to DC Amps position. Connect the black test lead (C), red test lead (D), starter motor, battery (E), and meter as shown in Figure 35.

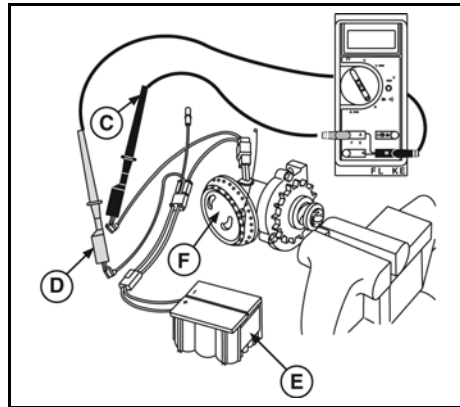


Figure 35

4. Using Tachometer #19200 (F), spin the starter motor and note RPMs and amperage draw. A starter motor in good condition will be:

- 1400 RPM (minimum)
- 9 Amps (maximum)

If starter motor is not within specifications, it must be replaced.

#### Test Interlock Switch

1. Disconnect interlock switch wires from spade terminals on switch.
2. Set meter to Ohms position.
3. Connect meter test leads to two spade terminals of switch (Figure 36). Meter should read no continuity. If switch fails, replace the switch. Push switch lever in until it clicks. Meter should read low resistance. If switch fails, replace the switch.

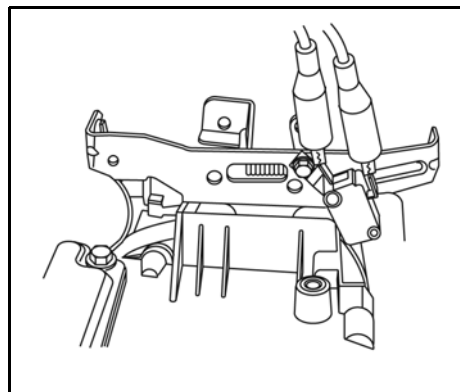


Figure 36

### Test Interlock Switch Wiring

1. Disconnect interlock switch wires from spade terminals on switch and at starter motor connection.
2. Set meter to Ohms position.
3. Connect one meter test lead to the end of one wire connector and other test lead to the opposite connector in the same wire (Figure 37). Meter should read low or no resistance.

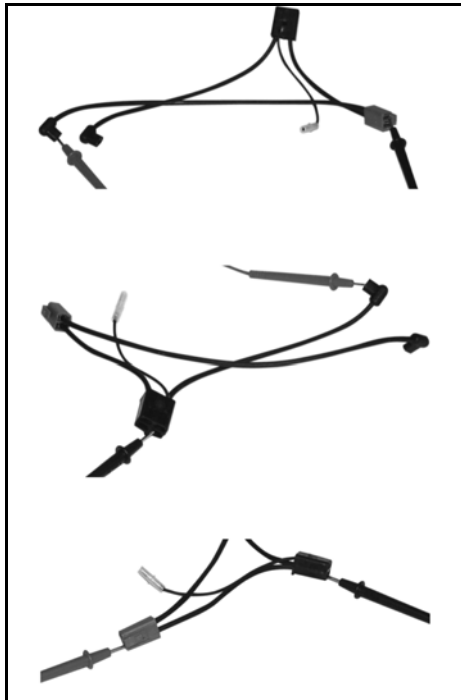


Figure 37

4. Move the wire inside the connector. Meter should not change value.
5. Replace or repair wiring if there is intermittent or no continuity. Repeat for each wire in the harness.

### 12 Volt DC Starter Motor

#### Model Series 120000, 150000, 200000, 210000, 280000, 310000, 330000

These starter motors were produced in three sizes to provide different cranking speeds and torque. The length of the motor housing determines the output as noted in the following procedures.

#### Check Starter Motor Drive and Clutch

When starter switch is activated, pinion gear should rise, engage flywheel ring gear, and crank engine. The pinion gear must rotate counterclockwise, as viewed from gear. If starter motor drive does not react properly, check helix and pinion gear for free operation. If the pinion gear sticks, clean the helix and gear with a mild solvent and compressed air. If the pinion continues to stick, replace the entire starter drive assembly.

**NOTE:** Do not oil the pinion gear or clutch helix.

The starter motor clutch is designed to prevent damage from shock loads such as engine backfire. If clutch slips while cranking, replace the entire starter drive assembly.

#### Test Starter Motor

1. Clamp starter motor test fixture in vise.
2. Remove starter motor from engine and mount to fixture.

**NOTICE:** Do not clamp motor housing in a vise or strike with a hammer. Starter motors contain ceramic magnets that can be damaged if the motor housing is hit, deformed, or dented.

3. Set meter to DC Amps position.
4. Connect the optional starter switch (A, Figure 38), starter motor, battery (F), black lead (C), red lead (D), shunt (E), and tachometer (B).

2



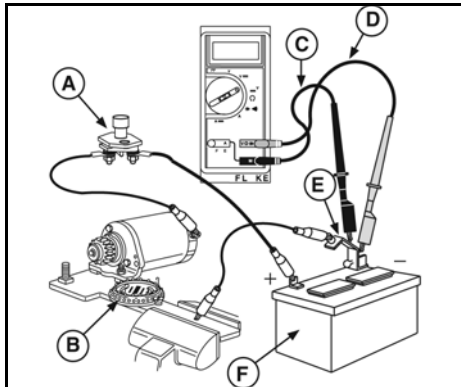


Figure 38

5. Activate starter motor and note readings of meter and tachometer. Take reading after meter stabilizes (approximately 2-3 seconds).
6. A starter motor in good condition will be between the following specs:
  - 6500 RPM (minimum) and 35 Amps (maximum)
  - OR-
  - 5000 RPM (minimum) and 20 Amps (maximum)
  - OR-
  - 7000 RPM (minimum) and 24 Amps (maximum)

If starter motor is not within specifications, it must be replaced.

#### Test Solenoid

Some engines or equipment have a solenoid mounted to the starter motor or to the frame of the equipment.

The solenoid is normally open. When the key switch is turned to the START position, the solenoid closes, allowing battery current to flow to the starter motor and crank the engine.

The solenoid may be tested while mounted on the engine or equipment. A jumper test lead (A, Figure 39) is required for this test.

1. Key switch must be in OFF position.
2. Remove positive (+) battery cable from battery and from stud terminal on solenoid.

3. Disconnect wire from tab terminal on solenoid.
4. Insert RED test lead into the V  $\Omega$  receptacle in the meter and insert BLACK test lead into COM receptacle in the meter.
5. Set meter to Diode position.
6. Attach one meter test lead to each stud terminal (B,C) on solenoid.

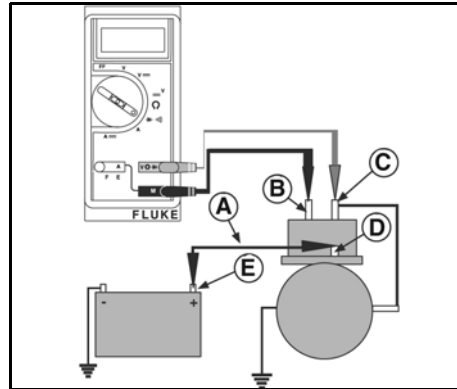


Figure 39

7. Attach one end of jumper lead to positive (+) battery terminal (E).
8. Touch other end of jumper lead to tab terminal (D) on solenoid. A click should be heard as the solenoid switch closes and the meter should indicate continuity. If solenoid fails this test, replace it.

#### 120-Volt AC Starter Motor

##### Model Series 120000, 150000, 200000, 210000





The 120-Volt AC starter motors are not serviceable. If a failure occurs, the entire motor/switch assembly must be replaced. Refer to the appropriate Illustrated Parts List to obtain replacement part numbers.

## BATTERIES

A 12 Volt, lead acid, wet cell battery is required to operate starter motors on Briggs & Stratton OHV single cylinder engines. This type is available as a wet charge or dry charge battery.

The wet charged maintenance-free battery is filled with electrolyte and sealed at the time production. The level of electrolyte cannot be checked.

The dry charge battery requires electrolyte to be added at the time the battery is placed in service. Before activating a dry charge battery, read and follow the manufacturer's recommended procedure.

 <b>WARNING</b>	
	Storage batteries give off explosive hydrogen gas during recharging. Slightest spark will ignite hydrogen and cause explosion.
	Battery electrolyte fluid contains acid and is extremely caustic. Contact with battery contents will cause severe chemical burns.
	A battery presents a risk of electrical shock and high short circuit current.
<ul style="list-style-type: none"><li>• DO NOT dispose of a battery in a fire.</li><li>• DO NOT allow any open flame, spark, heat, or lit cigarette during and for several minutes after charging a battery.</li><li>• DO NOT open or mutilate the battery.</li><li>• Wear protective goggles, rubber apron, and rubber gloves.</li><li>• Remove watches, rings, or other metal objects.</li><li>• Use tools with insulated handles.</li></ul>	

### Battery and Cable Recommendations

These battery size recommendations are based on minimum temperature expected and correct weight of oil being used.

- 30 Amp. Hr. +20°F (-6°C) or higher
- 40 Amp. Hr. -5°F (-20°C) or higher
- 50 Amp. Hr. -15°F (-26°C) or higher

These cable sizes are based on total distance from battery positive (+) post to starter switch or solenoid and to starter, plus the ground return to the battery negative (-) post.

- #6 AWG - 4 ft. (1.2m) or less
- #5 AWG - 5 ft. (1.5m) or less
- #4 AWG - 6 ft. (1.8m) or less



### WARNING

**Battery posts, terminals, and related accessories contain lead and lead compounds - chemicals known to the State of California to cause cancer and reproductive harm. Wash hands after handling.**

2

### Battery Installation

1. Before installing battery, connect all equipment to be operated.
2. Place battery in holder with a flat base. Tighten holder down evenly until snug. DO NOT over tighten.
3. Connect positive (+) cable to positive battery post FIRST, to prevent sparks from accidental grounding. Tighten connector securely.
4. Connect negative (-) cable to negative battery post. Tighten connector securely.

### Charging Battery

1. Clean the battery of all dirt and corrosion.
2. Clean, then lightly grease the terminals.
3. Bring battery to full charge using a taper charge (automatically reduces charge rate).

**NOTE:** Do not exceed charge rate of 1/10 ampere for every ampere of battery rating. Consult battery manufacturer for maximum charge recommendations.

**NOTE:** If battery gets hot to the touch or is spitting acid (gassing) excessively, unplug charger periodically.

4. With battery fully charged, check specific gravity readings of each cell with a temperature-compensated Battery Hydrometer (Figure 40). All readings should be above 1.250 (compensating for temperature). If specific gravity readings vary by .050 or if all cells read less than 1.225, replace battery.

2

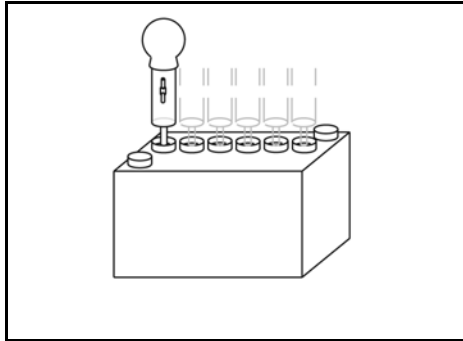


Figure 40

### Testing Battery

Set the digital multimeter to DC volts position.  
Test the battery while installed in the equipment.

1. Disconnect wire from spark plug and ground ignition using Ignition Tester #19368.
2. Attach RED meter test clip to positive (+) battery terminal. Attach BLACK meter test lead to negative (-) battery terminal.
3. Turn switch to START. Meter should display 9 volts or more while cranking engine. If less than 9 volts, replace battery.

**NOTICE:** To prevent damage to the starter motor, do not crank starter for more than 15 seconds without allowing starter to cool at least 2 minutes.

## EQUIPMENT AFFECTING ENGINE OPERATION

Frequently, what appears to be a problem with engine operation, such as hard starting or vibration, may be the fault of the equipment rather than the engine itself. Below are some common symptoms and potential equipment-related sources.

### Hard Starting or Will Not Start

1. Check for a loose drive belt or a loose blade, which will counteract engine cranking effort.
2. Check for parasitic load; disengage equipment controls before starting.
3. Check remote throttle/choke control for proper adjustment.
4. Check interlock system for shorted wires, loose or corroded connections, or defective modules or switches.

### Engine Won't Stop

1. Check equipment stop switch.
2. Check for loose or disconnected equipment stop switch wire.
3. Check engine ground wire harness.

### Vibration

1. Check for bent or out-of-balance cutter blades.
2. Check for loose, worn, or damaged drive belts and pulleys.
3. Check for loose mounting bolts.

## OIL GARD SYSTEMS

### Engine Will Not Start, On/Off Switch Light Flashes

1. Check engine oil level. If oil is between ADD and FULL, go to next step. If low, add oil to bring to FULL mark on dipstick. If engine starts and runs, problem corrected.
2. Disconnect wire from module to plug and terminal assembly on crankcase cover. Use Digital Multimeter #19464 to check resistance.
3. Rotate selector to (Ohms) position.
4. Insert RED test lead into the  $V \Omega$  receptacle in the meter.
5. Insert BLACK test lead (B) into COM receptacle.
6. Connect either test lead to plug and terminal.
7. Connect other test lead to crankcase cover (Figure 41). If meter reads Zero resistance, replace sensor in crankcase cover. If meter reads some resistance, go to next step.

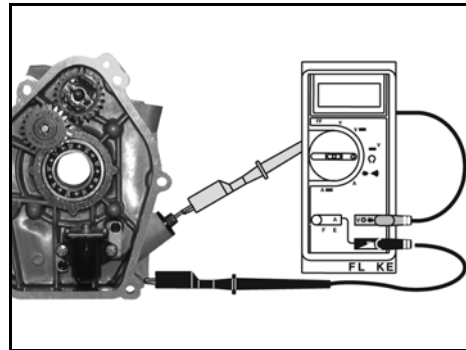


Figure 41

8. With module wire disconnected and not touching ground, try to start the engine. If engine starts, replace module. If engine does not start, check Oil Gard wiring for shorts to ground. Repair as needed.

**On/Off Switch Light Does Not Flash**

1. Check engine oil level. If low, add oil to bring to FULL mark on dipstick.
2. Try to start engine while shading ON/OFF switch light from bright light such as sunlight. If light does not flash, replace switch. If new switch still does not flash, go to next step.
3. Check wiring of ON/OFF switch. Wire from module with spade terminal should be on "L" terminal. RED ground wire should be on #3 terminal and BLACK wire from ignition armature should be on #2 terminal.

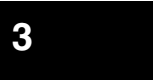
**Engine Starts and Runs With Low Oil**

1. Check wiring of ON/OFF switch per Step 3 in, "**Engine Will Not Start and ON/OFF Switch Light Does Not Flash.**" If wiring is correct, proceed to next step.
2. Check for oil sensor float stuck in open position per Step 2 in, "Engine Will Not Start, ON/OFF Switch Light Flashes." If stuck, replace. If not stuck, proceed to next step.
3. Check for opens in wiring. If no opens. replace module.

## SECTION 3 - EXHAUST SYSTEMS

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<b>SPARK ARRESTORS</b> .....	<b>-52</b>
<b>MUFFLER SERVICE</b> .....	<b>-52</b>
HORIZONTAL MODELS 110000, 120000, 150000 .....	52
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Some engines are equipped with exhaust systems (mufflers, brackets, and hardware) supplied by the OEM. Contact the OEM for muffler service information.

Exhaust systems covered in this section are those supplied by Briggs & Stratton.



### WARNING



Replacement parts must be the same and installed in the same position as the original parts or fire could result.

## 3

### Spark Arresters



### WARNING



Running engines produce heat. Engine parts, especially mufflers, become extremely hot.



Severe thermal burns can occur on contact.

Combustible debris, such as leaves, grass, brush, etc. can catch fire.

- Allow muffler, engine cylinder fins, and radiator to cool before touching.
- Remove accumulated debris from muffler area and cylinder fins.
- It is a violation of California Public Resource Code, Section 4442, to use or operate the engine on any forest-covered, brush-covered, or grass-covered land unless the exhaust system is equipped with a spark arrester, as defined in Section 4442, maintained in effective working order. Other States and Federal jurisdictions may have similar laws. Contact the original equipment manufacturer, retailer, or dealer to obtain a spark arrester designed for the exhaust system installed on this engine.

Remove spark arrester (A, Figure 1) for cleaning and inspection monthly or every 50 hours. If screen is deteriorated or perforated, it must be replaced.

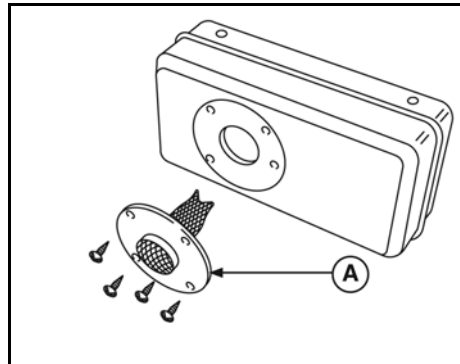


Figure 1

## MUFFLER SERVICE

### Horizontal Models 110000, 120000, 150000

Shown is a typical muffler application (Figure 2).

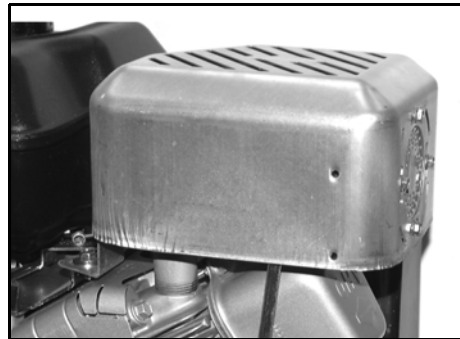


Figure 2

### Remove Guard and Muffler

1. Remove screws (A, Figure 3) holding muffler guard to muffler.
2. Remove screw (B) holding muffler guard to control bracket. Remove muffler guard and set aside.

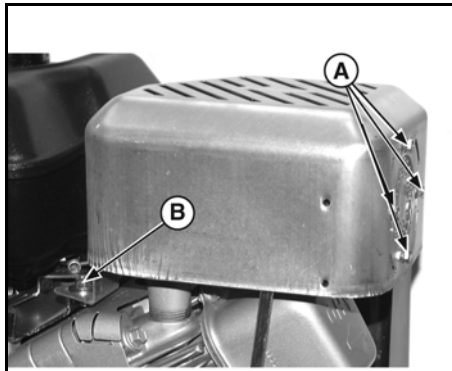


Figure 3

3. Remove screws (A, Figure 4) holding upper muffler bracket to lower muffler bracket.



Figure 4

4. Unscrew muffler from exhaust elbow and pipe assembly.
5. Remove and disassemble elbow and pipe assembly, if required.

#### Inspect Exhaust System

All exhaust system components must be inspected whenever the exhaust system is disassembled. Check muffler mounting bracket and/or muffler adapters for cracked welds or breakage. Check muffler for split seams, loose internal parts, or cracked welds. Replace any damaged parts with new OEM parts.

**Never reinstall broken or damaged components.**

#### Install Muffler and Guard

1. Coat threads of pipe with Valve Guide Lubricant #93963. Thread pipe into cylinder head exhaust port (A, Figure 5).
2. Coat exposed threads of elbow with Valve Guide Lubricant #93963. Install elbow (B) on pipe (C) and tighten securely with outlet straight out from cylinder head.

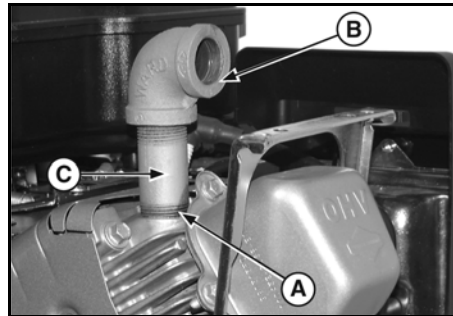


Figure 5

3. Coat the threads of the muffler with Valve Guide Lubricant # 93963, then thread exhaust muffler into elbow until secure.
4. Place upper muffler bracket over muffler and on lower muffler bracket. Install screws (A, Figure 6) and torque to values listed in Section 12 - Engine Specifications.



Figure 6

5. Place muffler guard over muffler and start screw (A, Figure 7) but do not tighten.
6. Line up holes in guard and end of muffler then start screws (B). Tighten all screws to values listed in Section 12 - Engine Specifications.

3



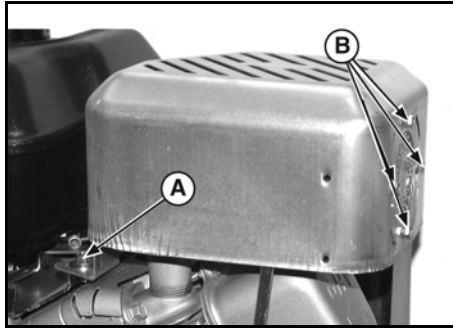


Figure 7

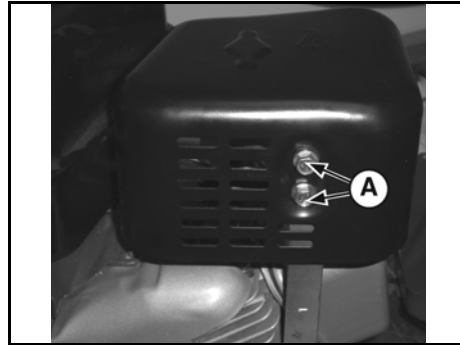


Figure 9

3

### Horizontal Models 200000, 210000

Shown is a typical muffler application (Figure 8).



Figure 8

#### Remove Guard and Muffler

1. Remove screws (A, Figure 9) holding muffler guard to muffler.
2. Remove screw holding muffler guard to control bracket. Remove muffler guard and set aside.



Figure 10

4. Remove the exhaust pipe screws, muffler assembly, and gaskets. Discard gaskets (Figure 11).

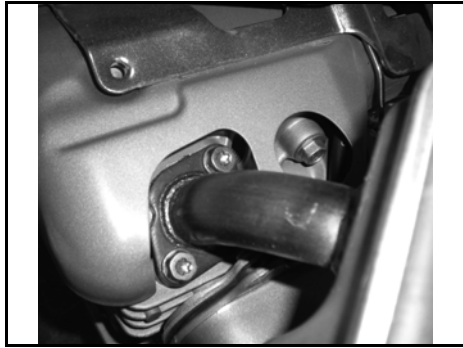


Figure 11

### Inspect Exhaust System

All exhaust system components must be inspected whenever the exhaust system is disassembled. Check muffler mounting bracket and/or muffler adapters for cracked welds or breakage. Check muffler for split seams, loose internal parts, or cracked welds. Replace any damaged parts with new OEM parts.

**Never reinstall broken or damaged components.**

### Install Muffler and Guard

1. Coat mounting screws with Valve Guide Lubricant #93963.
2. Place new exhaust gasket on cylinder head and place exhaust pipe flange on gasket.
3. Install screws at exhaust pipe and torque to values listed in Section 12 - Engine Specifications.
4. Install muffler support screws and torque to values listed in Section 12 - Engine Specifications.
5. Lightly coat muffler guard mounting screws with Valve Guide Lubricant #93963.
6. Place muffler guard over muffler and install screws into control bracket and side of muffler. Torque to values listed in Section 12 - Engine Specifications.

### Horizontal Models 120000, 150000, 200000, 210000 (Snow Series)

Shown are typical muffler applications (Figure 12 and Figure 13).

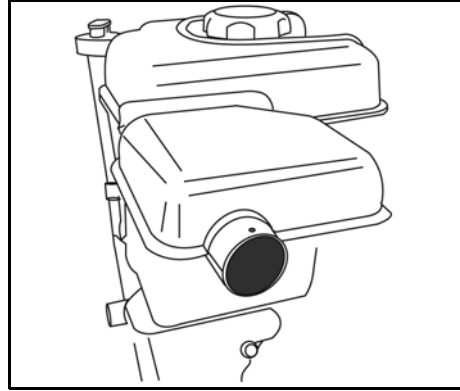


Figure 12

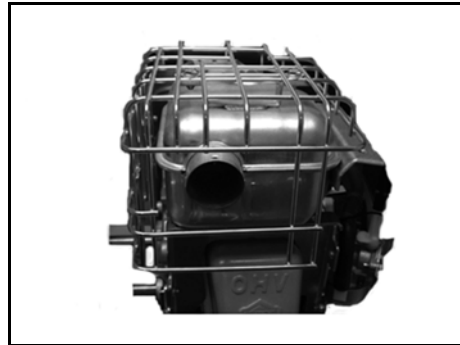


Figure 13

### Remove Guard and Muffler

1. Remove screws (A, Figure 14) holding muffler guard to muffler.
2. Remove screw holding muffler guard to control bracket. Remove muffler guard and set aside.

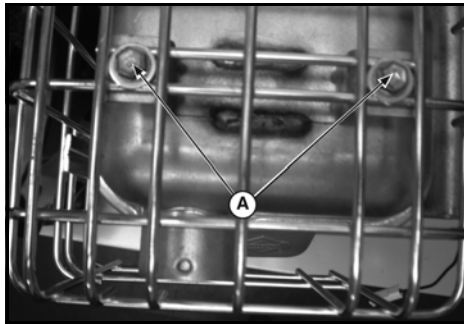


Figure 14

3

3. Remove muffler support screws (A, Figure 15).

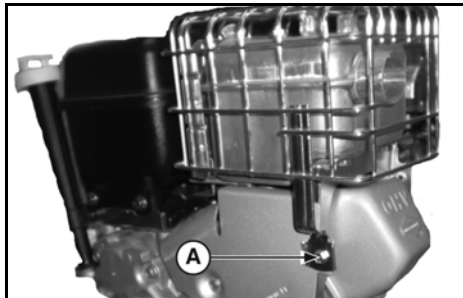


Figure 15

4. Remove the exhaust pipe screws, muffler assembly, and gaskets. Discard gaskets.

#### Inspect Exhaust System

All exhaust system components must be inspected whenever the exhaust system is disassembled. Check muffler mounting bracket and/or muffler adapters for cracked welds or breakage. Check muffler for split seams, loose internal parts, or cracked welds. Replace any damaged parts with new OEM parts.

**Never reinstall broken or damaged components.**

#### Install Muffler and Guard

1. Coat mounting screws with Valve Guide Lubricant #93963.
2. Place new exhaust gasket on cylinder head and place exhaust pipe flange on gasket.

3. Install screws at exhaust pipe and torque to values listed in Section 12 - Engine Specifications.
4. Install muffler support screws and torque to values listed in Section 12 - Engine Specifications.
5. Lightly coat muffler guard mounting screws with Valve Guide Lubricant #93963.
6. Place muffler guard over muffler and install screws into control bracket and top of muffler. Torque to values listed in Section 12 - Engine Specifications.

#### Vertical Models 97700, 99700, 110000, 120000

Shown is a typical muffler application (Figure 16).



Figure 16

#### Remove Guard and Muffler

1. Remove finger guard (A, Figure 17) and fuel tank (B) from top of engine.

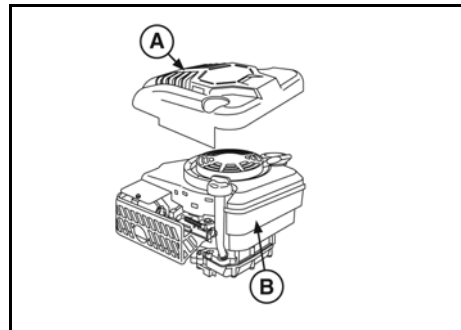


Figure 17

- Remove screws holding muffler guard (A, Figure 18). Remove guard and set aside.

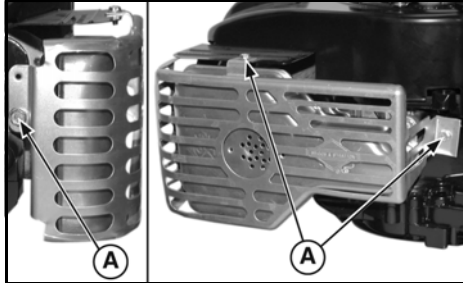


Figure 18

- Remove dipstick and oil fill tube (A, Figure 19).
- Remove blower housing and rewind starter (B).

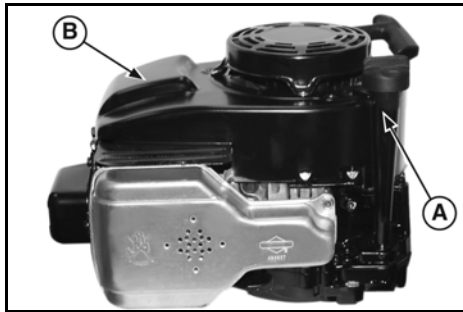


Figure 19

- Remove screws (A, Figure 20) holding exhaust pipe flange to cylinder head.
- Remove screw (B) holding muffler bracket to cylinder head.
- Remove screw (C) holding muffler to cylinder.
- Remove muffler assembly and muffler gasket from cylinder head. Discard gasket.

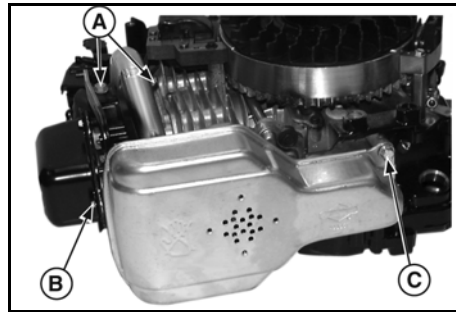


Figure 20

### Inspect Exhaust System

All exhaust system components must be inspected whenever the exhaust system is disassembled. Check muffler mounting bracket and/or muffler adapters for cracked welds or breakage. Check muffler for split seams, loose internal parts, or cracked welds. Replace any damaged parts with new OEM parts.

**Never reinstall broken or damaged components.**

### Install Muffler and Guard

- Coat mounting screws with Valve Guide Lubricant #93963.
- Place new exhaust gasket on cylinder head and place exhaust pipe flange on gasket.
- Start screws (A, Figure 21) at exhaust pipe but do not tighten.
- Start screw (B) in muffler bracket to cylinder head.
- Start screw (C) in muffler to cylinder bracket.
- Torque all screws to values listed in Section 12 - Engine Specifications.

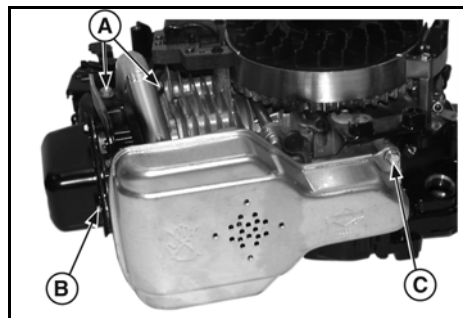


Figure 21

3

3

7. Install blower housing and rewind starter.
8. Install oil fill tube and dipstick.
9. Lightly coat muffler guard mounting screws with Valve Guide Lubricant #93963.
10. Place muffler guard over muffler and start screws (A, B, C, Figure 22). Torque to values listed in Section 12 - Engine Specifications.

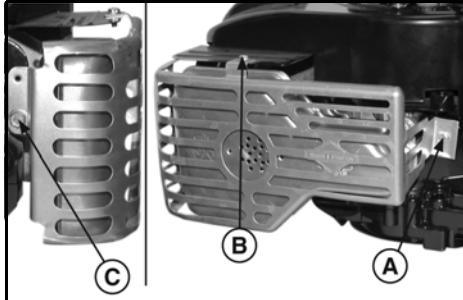


Figure 22

### Vertical Models 210000, 280000, 310000, 330000 with Clamped Muffler

Shown is a typical muffler application (Figure 23).

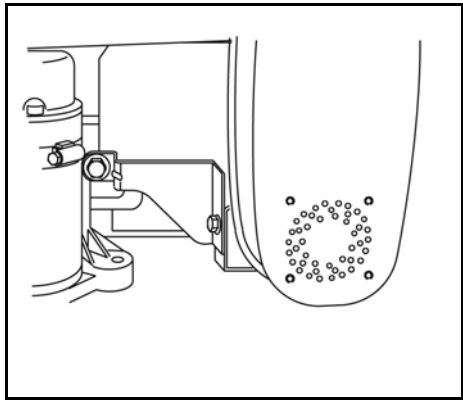


Figure 23

### Remove Muffler

1. Remove muffler brace screws (A, B, C, Figure 24) and supports.
2. Loosen muffler clamp (D) and slide muffler off adapter.

3. Remove adapter screws, adapter, and gaskets. Discard gaskets.

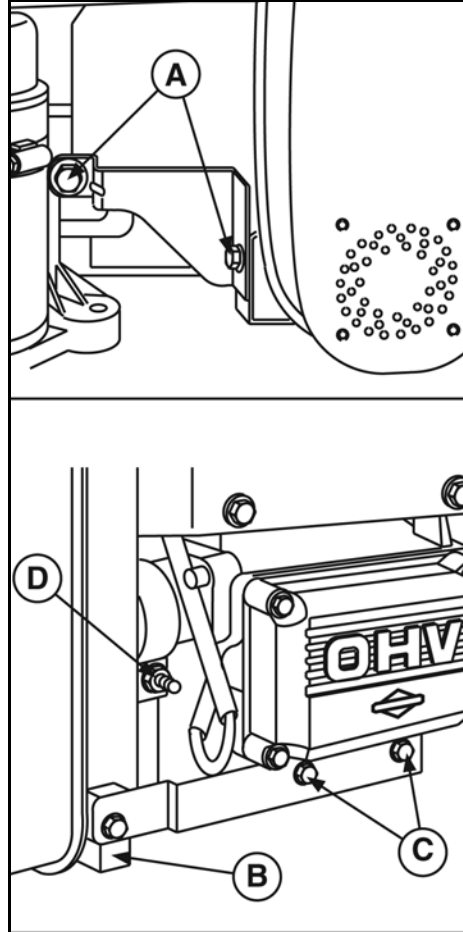


Figure 24

### Inspect Exhaust System

All exhaust system components must be inspected whenever the exhaust system is disassembled. Check muffler mounting bracket and/or muffler adapters for cracked welds or breakage. Check muffler for split seams, loose internal parts, or cracked welds. Replace any damaged parts with new OEM parts.

**Never reinstall broken or damaged components.**

### Install Muffler

1. Lightly coat muffler adapter screws with Valve Guide Lubricant #93963.
2. Install new gasket and adapter. Install screws (A, Figure 25) and torque to values listed in Section 12 - Engine Specifications.

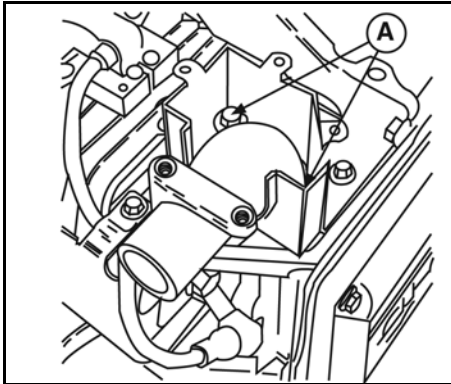


Figure 25

3. Install muffler supports and start but do not tighten screws (A, B, C, Figure 26).
4. Slide muffler and muffler clamp on adapter.
5. Torque muffler support screws (A, B, C) to values listed in Section 12 - Engine Specifications.
6. Torque muffler clamp (D) to values listed in Section 12 - Engine Specifications.

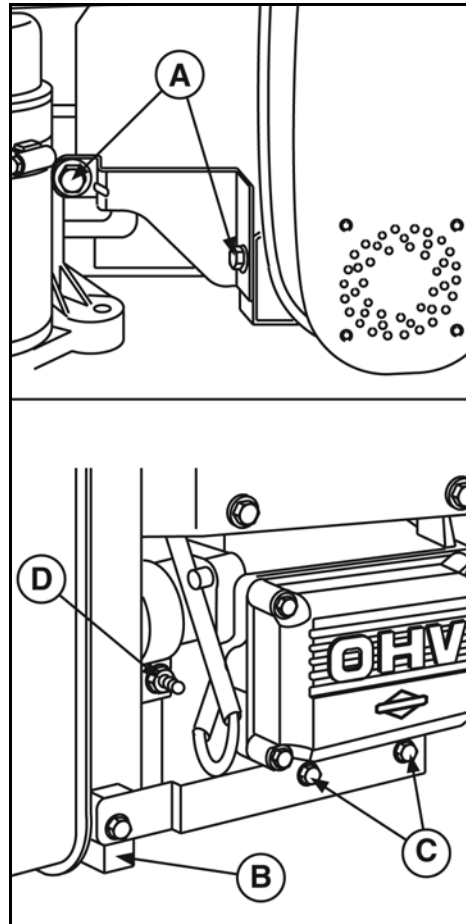


Figure 26

3

### Vertical Models 280000, 310000, 330000 with Bolt-On Muffler

Shown is a typical muffler application  
(Figure 27).

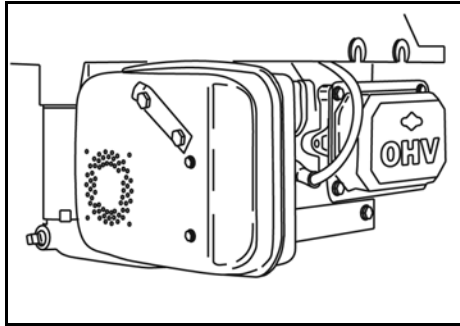


Figure 27

#### Remove Muffler

1. Remove muffler support screw (C, Figure 28).
2. Bend back tabs (A) on screw lock and remove mounting screws (B), muffler, and gasket. Discard screw lock and gasket.
3. Remove adapter screws, adapter, and gasket. Discard gasket.

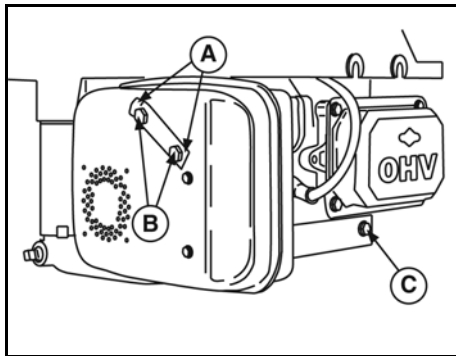


Figure 28

#### Inspect Exhaust System

All exhaust system components must be inspected whenever the exhaust system is disassembled. Check muffler mounting bracket and/or muffler adapters for cracked welds or breakage. Check muffler for split seams, loose internal parts, or cracked welds. Replace any damaged parts with new OEM parts.

**Never reinstall broken or damaged components.**

#### Install Muffler

1. Lightly coat muffler adapter screws with Valve Guide Lubricant #93963.
2. Install new gasket and adapter. Install screws (A, Figure 29) and torque to values listed in Section 12 - Engine Specifications.

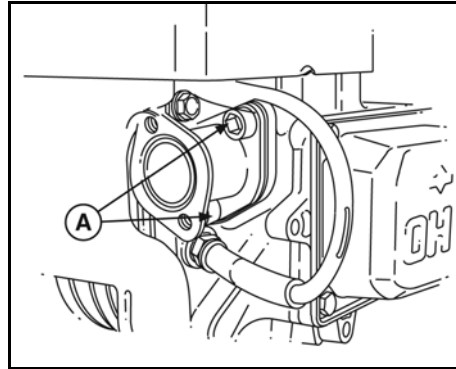


Figure 29

3. Install muffler screws with new screw lock into muffler and place new exhaust gasket on end of screws.
4. Place muffler assembly on muffler adapter and start screws, but do not tighten.
5. Start muffler support screw and hand-tighten.
6. Torque all screws to values listed in Section 12 - Engine Specifications.
7. Bend the screw lock tabs up against the head of the mounting screws.

## SECTION 4 - FUEL SYSTEMS AND CARBURETION

---

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## FUEL SYSTEMS

4



### WARNING



**Gasoline and its vapors are extremely flammable and explosive.**



**Fire or explosion can cause severe burns or death.**

#### When adding fuel:

- Turn engine OFF and let engine cool for at least 2 minutes before removing the fuel cap.
- Fill fuel tank outdoors or in a well-ventilated area.
- Do not overfill fuel tank. To allow for expansion of the gasoline, do not fill above the bottom of the fuel tank neck.
- Keep gasoline away from sparks, open flames, pilot lights, heat and other ignition sources.
- Check fuel lines, tank, cap, and fittings frequently for cracks or leaks. Replace if necessary.
- If fuel spills, wait until it evaporates before starting engine.

#### When starting engine:

- Make sure spark plug, muffler, fuel cap, and air cleaner are in place.
- Do not crank engine with spark plug removed.
- If fuel spills, wait until it evaporates before starting engine.
- If engine floods, set choke (if equipped) to **OPEN/RUN** position. Place throttle (if equipped) in **FAST** and crank until engine starts.

#### When operating equipment:

- Do not tip engine or equipment at an angle which would cause fuel to spill.
- Do not choke carburetor to stop engine.
- Never start or run the engine with the air cleaner assembly (if equipped) or the air filter (if equipped) removed.

#### When changing oil:

- If you drain the oil from the top oil fill tube, the fuel tank must be empty or fuel can leak out and result in a fire or explosion.

#### When transporting equipment:

- Transport with fuel tank empty or with fuel shut-off valve set to OFF.

#### When storing gasoline or equipment with fuel in the tank:

- Store away from furnaces, stoves, water heaters, or other appliances that have a pilot light or other ignition source because they can ignite gasoline vapors.



### WARNING



Never start or operate engine with air cleaner removed, fire can result.



### WARNING



**Unintentional sparking can result in fire or electrical shock.**



**Unintentional start-up can result in entanglement, traumatic amputation, or severe lacerations.**



#### Before performing adjustments or repairs:

- Disconnect spark plug wire and keep it away from spark plug.
- Disconnect the negative (-) battery terminal.



### WARNING

Before servicing the carburetor or other fuel system components, drain all fuel from the tank and turn OFF the fuel valve (if equipped).

**NOTE:** Replace air cleaner gaskets and mounting gaskets whenever carburetor is removed for service.

**NOTE:** Do not insert a screw in the end of the fuel hose to stop fuel flow. Screw threads will loosen rubber particles which will get into the carburetor.

**NOTE:** Before servicing the carburetor, turn the fuel shutoff valve to the OFF position.

## Fuel Pump

The fuel pump, mounted near the blower housing and the air cleaner cover, allows remote fuel tank installations on some engines. The pump is operated by vacuum pulses from the engine.

**NOTE:** The fuel pump itself is not serviceable. If the pump does not operate after inspection and proper installation, replace the pump.

### Removal

1. Close the fuel shut-off valve, if equipped.
2. Release clamps and disconnect fuel lines (A, Figures 1 and 2) and vacuum line (B) from the fuel pump (C).
3. Disassemble shut-off valve and fuel filter, if equipped, from hoses and set aside.
4. Remove the two screws that secure the fuel pump and mounting bracket.

### Inspection

Inspect fuel pump for:

- Restrictions or leaks in vacuum or fuel lines
- Cracks or distortion in pump body or base.
- Stiff or brittle hoses.

Check shutoff valve and filter for damage or contamination, and replace parts as necessary.

### Installation

1. Install two screws in fuel pump and mounting bracket and torque to values listed in Section 12 - Engine Specifications.
2. Reassemble shutoff valve and fuel filter, if equipped, to fuel line. Secure with clamps.
3. Connect vacuum line (B) and fuel lines (A) to the fuel pump (C). Secure with clamps.
4. Start engine and inspect fuel pump and hose connections for leaks.

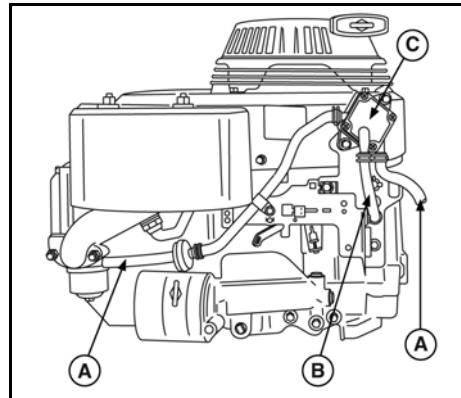


Figure 1

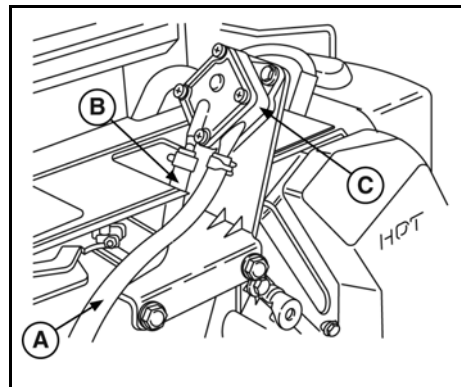


Figure 2

## Fuel Filter

Some engines are equipped with a fuel filter (Figure 3) mounted in-line between the fuel tank and the carburetor. Replace the filter annually or whenever fuel system service is performed.

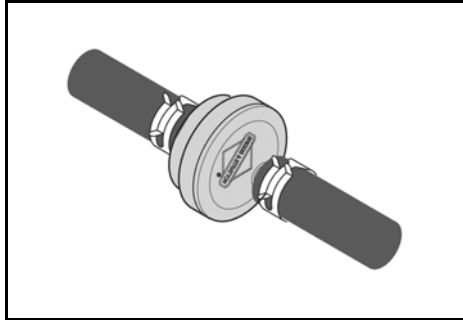


Figure 3

1. Drain the fuel tank or close the fuel shut-off valve, if equipped.
2. Slide the clamps away from the fuel filter. Twist and pull the fuel lines off of the fuel filter. Discard filter.
3. Check the fuel lines for cracks or leaks. Replace if necessary.
4. Install a new filter between the fuel lines and secure with the clamps. Open the shutoff valve and check for leaks.

## Fuel Tanks and Shut-off Valves

### Horizontal Models 110000, 120000, 150000, 200000, 210000

#### Removal

1. Close shut-off valve, if equipped.
2. Remove air cleaner assembly per Section 1 - Safety, Maintenance, and Adjustments.

**NOTE:** Snow engines do not have an air cleaner assembly. Remove the 1 or 2 piece shroud to gain access to the carburetor.

3. Remove screws (A, Figure 4) and the control panel/ trim plate.

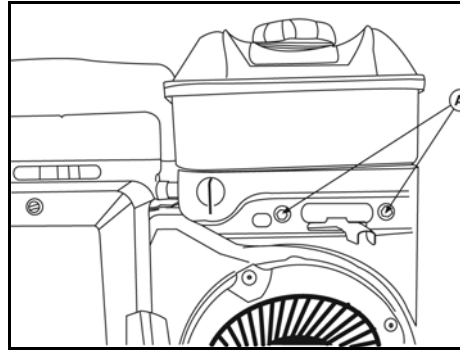


Figure 4

4. Release hose clamp and disconnect fuel hose from carburetor fitting.
5. Place hose in appropriate container, open shut-off valve, and allow fuel to completely drain from tank.
6. Remove shut-off valve and filter, if equipped, from hose and set aside.
7. Remove the mounting screws from tank support. Carefully slip fuel hose under governor link and allow spark plug wire to slip through hole in support as tank is removed.
8. Remove tank support from tank, if equipped.

#### Inspection

1. Clean gummy or dirty fuel tanks with Briggs & Stratton Carburetor Cleaner #100041 or #100042, or equivalent.
2. Inspect fuel tank for:
  - Corrosion
  - Leaks
  - Broken mounting brackets
3. Check fuel cap and filler neck for:
  - Proper seals
  - Vents
  - Functional quantity gauge (if equipped)
4. Check fuel filter for blockage of any kind.
5. Check fuel shut off valve for proper operation.

Clean or replace parts as required. Fuel filter replacement is recommended annually or any time the fuel system is serviced.

### Installation

1. Install tank support to tank. Slip fuel hose under governor link and spark plug wire through hole in support as tank is installed. Torque screws to values listed in Section 12 - Engine Specifications.
2. Assemble shut-off valve and fuel filter, if equipped, to fuel hose.
3. Install hose assembly to tank fitting and carburetor fitting with new clamps.
4. Install control panel/trim plate. Torque screws to values listed in Section 12 - Engine Specifications.
5. Add small amount of fuel to tank, open shut off valve, and check for leaks. Repair as necessary.
6. Install air cleaner assembly per Section 1.

**NOTE:** For snow engines, install the 1 or 2 piece shroud.

7. Start engine and check for leaks. Repair as necessary.

### Vertical Models 97700, 99700, 110000, 120000

#### Removal

1. Drain the fuel tank.
2. Remove air cleaner cover and gas cap.
3. Remove screws and/or pry off the decorative cover (A, Figure 5) installed on the blower housing.
4. Remove screws (B) around the rewind starter and at the bottom of the tank. Release clamp and pull hose off tank fitting, then lift tank off engine.

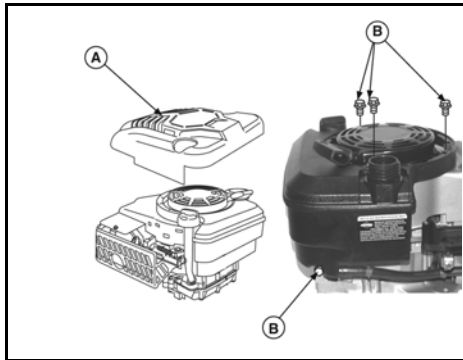


Figure 5

### Inspection

1. Clean gummy or dirty fuel tanks with Briggs & Stratton Carburetor Cleaner #100041 or #100042, or equivalent.
2. Inspect fuel tank for:
  - Corrosion
  - Leaks
  - Broken mounting brackets
3. Check fuel cap and filler neck for:
  - Proper seals
  - Vents
  - Functional quantity gauge (if equipped)
4. Check fuel filter for blockage of any kind.
5. Check fuel shut off valve for proper operation

Clean or replace parts as required. Fuel filter replacement is recommended annually or anytime the fuel system is serviced.

### Installation

1. Install fuel hose to tank fitting and secure with hose clamp. Position tank on engine and install screws at bottom of tank and around rewind starter. Torque screws to values in Section 12 - Engine Specifications.
2. Install decorative cover with screws or by snapping tabs into place.
3. Install gas cap and air cleaner cover.
4. Partially fill tank with fuel and check for leaks. Repair as necessary.

### Vertical Model 210000

#### Removal

1. Close shut-off valve, if equipped.
2. Move clamp and disconnect fuel hose and fuel pump fitting. Place hose in appropriate container, open shut-off valve, and allow fuel to completely drain from tank.
3. Move clamp and disconnect fuel hose from tank fitting. Remove shut-off valve and filter, if equipped, from hose and set aside.
4. Remove two bolts with spacers from side of tank, the remove tank from mounting bracket.

5. If necessary, remove two nuts from bracket and slide bracket off cylinder head studs.

### Inspection

1. Clean gummy or dirty fuel tanks with Briggs & Stratton Carburetor Cleaner #100041 or #100042, or equivalent.
2. Inspect fuel tank for:
  - Corrosion
  - Leaks
  - Broken mounting brackets
3. Check fuel cap and filler neck for:
  - Proper seals
  - Vents
  - Functional quantity gauge (if equipped)
4. Check fuel filter for blockage of any kind.
5. Check fuel shut-off valve for proper operation.

Clean or replace parts as required. Fuel filter replacement is recommended annually or any time the fuel system is serviced.

### Installation

1. Slide mounting bracket (if removed) on cylinder head studs. Install nuts and torque to values listed in Section 12 - Engine Specifications.

**NOTE:** Bracket is offset to allow clearance for the intake manifold.

2. Position tank in bracket. Install two bolts with spacers and torque to values listed in Section 12 - Engine Specifications.
3. Assemble shut-off valve and fuel filter, if equipped, to fuel hose.
4. Install hose assembly to fuel pump fitting and secure with clamp, then install to tank fitting and secure with clamp.
5. Partially fill tank with fuel and check for leaks. Repair as necessary.

## CARBURETION

### Carburetor Identification

- Figure 6 - LMS, Models 97700, 99700, 110000, 120000, 150000 Vertical and Horizontal Shaft
- Figure 7 - ReadyStart®, Models 110000, 120000 Vertical Shaft
- Figure 8, Figure 9 - LMT, Models 200000, 210000, 280000, 310000, 330000 Vertical and Horizontal Shaft
- Figure 10 - Nikki, Models 280000, 310000, 330000 Vertical Shaft
- Figure 11 - Nikki LP / NG Mixer Gaseous Fueled Vertical Shaft

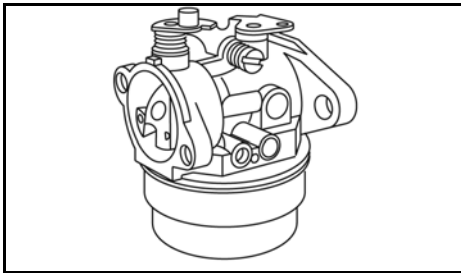


Figure 6

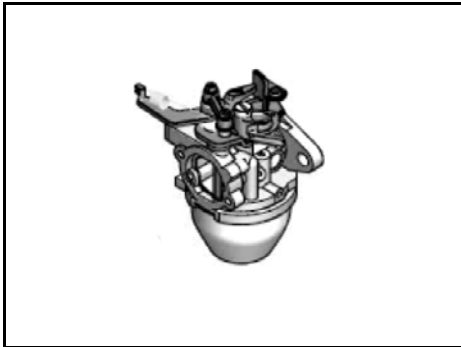


Figure 7

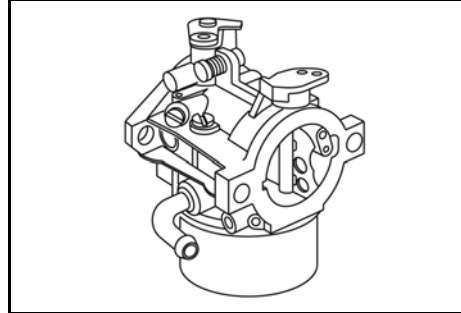


Figure 8

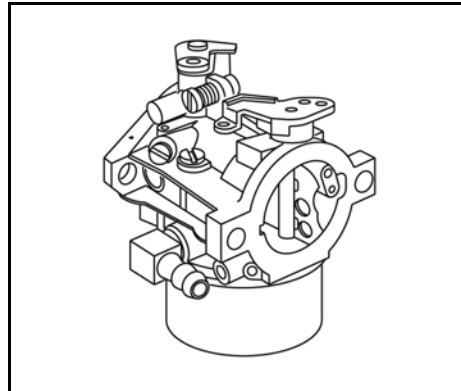


Figure 9



Figure 10

4

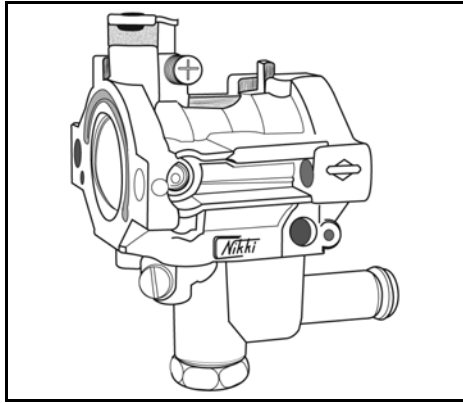


Figure 11

4



**WARNING**

Before servicing the carburetor or other fuel system components, drain all fuel from the tank and turn OFF the fuel valve (if equipped). Do not attempt to stop fuel flow by plugging the fuel hose.

**NOTE:** Consult the Illustrated Parts List to obtain the appropriate carburetor overhaul kit before reassembling the carburetor.

**NOTE:** Many early carburetors had adjustable needle valves to compensate for high altitude conditions. Later carburetors use replaceable main jets to compensate for various high altitude ranges. See the appropriate Illustrated Parts List for replacement needle valves or jets.

**Carburetor Service**

**LMS Carburetor**

**Vertical Models 97700, 99700, 110000, 120000**

The exact type of LMS carburetor can be identified by a number stamped on the edge of the mounting flange (A, Figure 12). These carburetors have a fixed high-speed main jet and a non-adjustable idle mixture (except on early production models), and are available in manual/remote choke or Choke-a-Matic® versions.

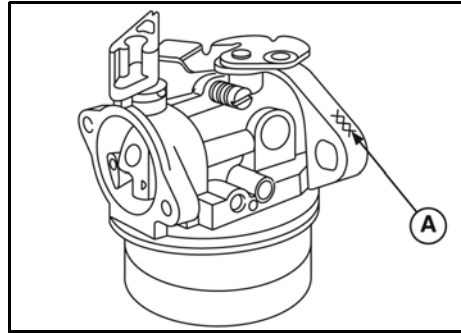


Figure 12

**Remove Carburetor**



**WARNING**

Before servicing the carburetor or other fuel system components, drain all fuel from the tank and turn OFF the fuel valve (if equipped). Do not attempt to stop fuel flow by plugging the fuel hose.

1. Remove air cleaner assembly per Section 1. Discard the gasket.
2. Move clamp and disconnect fuel hose from carburetor.
3. Disconnect the Choke-a-Matic® spring, if equipped, from choke lever (A, Figure 13, Figure 14).

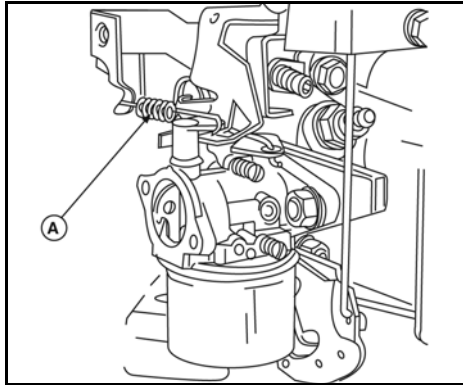


Figure 13

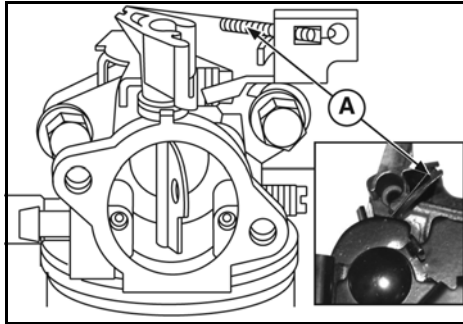


Figure 14

4. Remove two carburetor mounting screws.
5. Pull carburetor away from the control bracket assembly and rotate it to disengage the governor link from the grommet on top of the throttle shaft lever.

**NOTE:** On early production models, the mounting screws also retained the control bracket. Reinstall these screws to retain the bracket until the carburetor is reinstalled.

6. Remove the spacer, o-ring, and gasket, if equipped. Discard the o-ring and the gasket.

#### Disassemble Carburetor

1. Remove the fixed main jet (bowl nut) and fiber washer, then remove the fuel bowl and the bowl gasket from the carburetor body. Discard the fiber washer and the gasket.
2. Remove the float hinge pin (C, Figure 15), float (D), and inlet needle (E). If the needle has a metal tip, also remove the soft needle seat in the carburetor body.

Discard the hinge pin, inlet needle, and seat.

**NOTE:** On Model 97700, remove the main jet (A) and float disc (B) before removing the hinge pin, float, and needle.

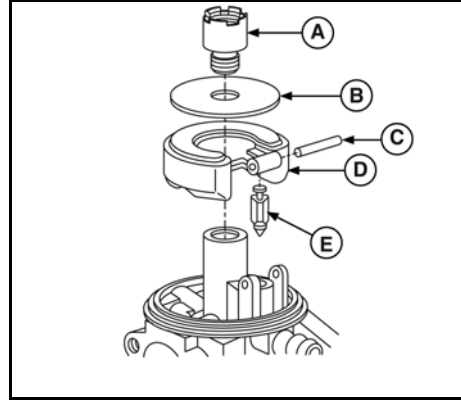


Figure 15

3. Remove idle speed screw with spring (B, Figure 16). Remove limiter cap and idle mixture screw with spring, if equipped.
4. Rotate throttle shaft (C) to the closed position. Remove throttle valve screws (F), then remove the throttle valve. Slide out the throttle shaft with the foam seal. Discard the seal.
5. Grasp choke valve and remove from choke shaft (A). Slide out choke shaft with the foam seal. Discard the seal.
6. With a modified pin punch (E), remove and discard Welch plug (D) from carburetor body.

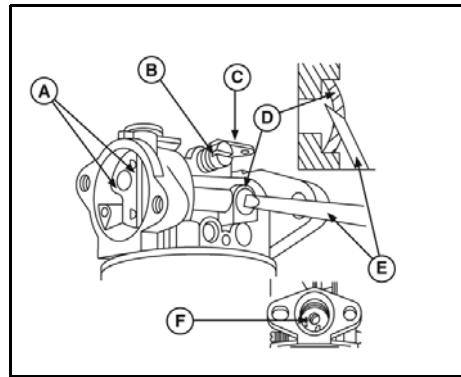


Figure 16



### Inspect and Clean Carburetor Components

1. Inspect openings in the carburetor body for evidence of wear or damage. If found, replace the entire carburetor assembly.
2. Inspect the choke shaft, choke valve, throttle shaft, and throttle valve for evidence of wear or damage. Replace parts as necessary.
3. Using Carb/Choke Cleaner #100041 or #100042, thoroughly clean the following components, then follow with compressed air to dry:
  - Passages in the fixed main jet (bowl nut)
  - Inside and outside of the fuel bowl
  - Float
  - Choke shaft and choke valve
  - Throttle shaft and throttle valve
  - All passages, openings, and the inside and outside of the carburetor body

**NOTE:** Do not soak non-metallic components, such as floats, o-rings, seals, or diaphragms, in carb/choke cleaner or they will be damaged.

4. If any passages remain plugged after cleaning, replace the component or the entire carburetor assembly.

### Assemble Carburetor

Consult the Illustrated Parts List to obtain the appropriate carburetor overhaul kit before reassembling the carburetor.

1. Install new Welch plug (**A**, Figure 17) with a pin punch (**B**) of slightly smaller diameter than the plug. Press against the plug until it is flat in the carburetor opening. Do not cave in the plug. Seal the edge of the plug with a non-hardening sealant.

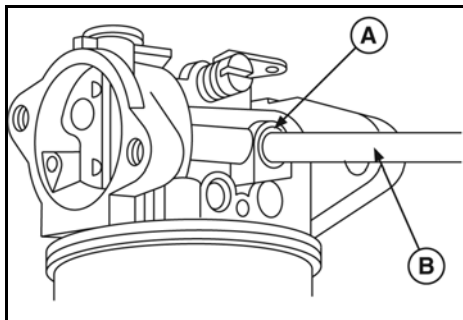


Figure 17

2. Install new foam seal (**B**, Figure 18) on choke shaft (**E**), then slide shaft into carburetor body (**C**). Rotate shaft clockwise (**A**), and insert choke valve into slot until centered, with dimples (**D**) positioned as shown. Actuate the choke shaft to check for proper movement.

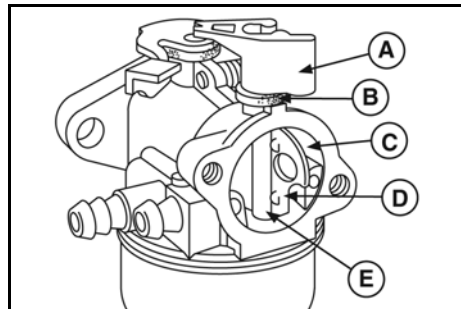


Figure 18

3. Install new foam seal (**C**, Figure 19) on throttle shaft (**B**), then slide shaft into carburetor body. Rotate shaft until flat is facing out. Position throttle valve on flat with numbers facing out (**A**), then install screws (**D**). Actuate the throttle shaft to check for proper movement.

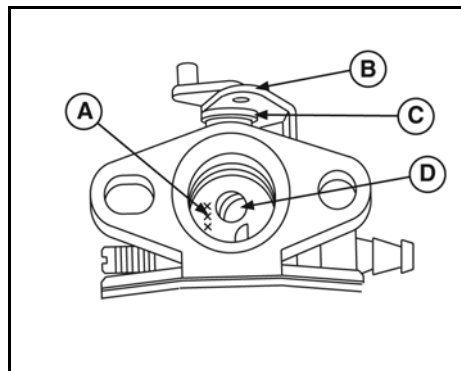


Figure 19

4. Install idle speed screw and spring. Install idle mixture screw and spring with a new limiter cap, if equipped.
5. Using Bushing Driver #19057 (**A**, Figure 20), install new needle seat with grooved edge down (**B**) until firmly seated.

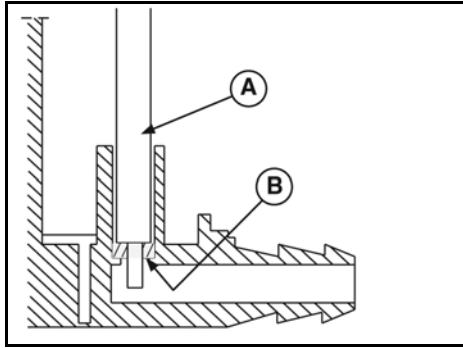


Figure 20

6. Install new inlet needle (E, Figure 21) on float (D), then position float in carburetor body. Secure with new hinge pin (C) and center the pin between the float bosses.

**NOTE:** On Model 97700, install the flat disc (B) and main jet (A).

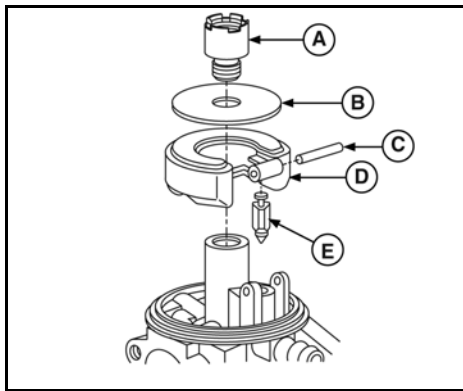


Figure 21

7. Place new bowl gasket on carburetor body and install fuel bowl. Place new fiber washer on fixed main jet (bowl nut) and install. Torque to values listed in Section 12 - Engine Specifications.

### Install Carburetor

**NOTE:** Always replace air cleaner gaskets and carburetor mounting gaskets any time the carburetor has been removed for service.

1. Remove mounting screws from control bracket, if reinstalled.
2. Hook z-bend of governor link into grommet on top of the throttle shaft lever.

3. Place new gaskets or o-rings between control bracket (D, Figure 22), adapter (if equipped), and carburetor.
4. Position carburetor on control bracket or adapter and install screws (C). Torque to value listed in Section 12 - Engine Specifications.

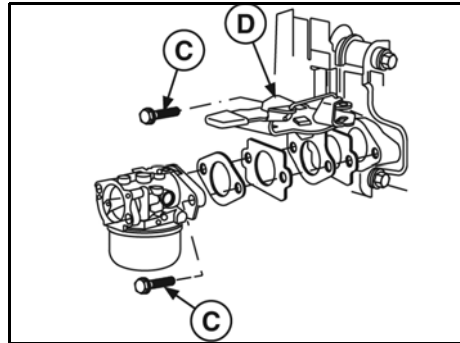


Figure 22

**NOTE:** Use new screws or apply Loctite® to original screws to prevent loosening from vibration.

5. Connect the Choke-a-Matic® spring (if equipped) to choke lever (A, Figure 23, Figure 24).

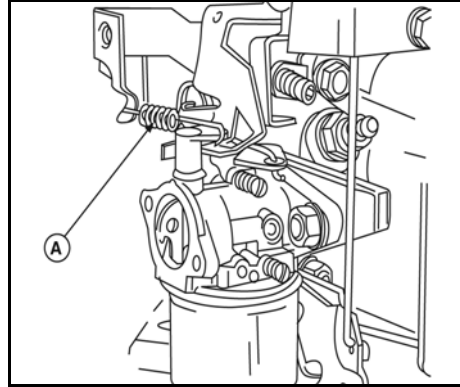


Figure 23

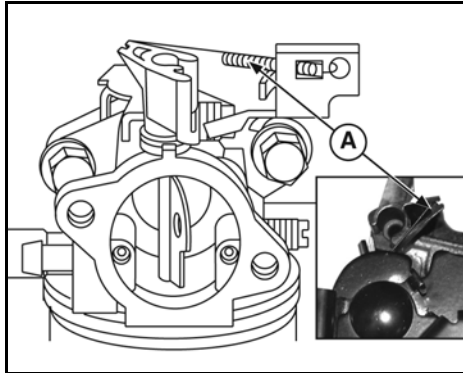


Figure 24

6. Connect fuel hose to carburetor and secure with clamp.
7. Using new gasket, install air cleaner assembly to carburetor per Section 1. Ensure breather hose is properly installed on the breather tube.
8. Adjust carburetor, if applicable, per Section 1.

4

### LMS Carburetor

#### Horizontal Models 110000, 120000, 150000

The exact type of LMS carburetor can be identified by a number stamped on the edge of the mounting flange (A, Figure 25). These carburetors have a fixed high speed main jet, a non-adjustable idle mixture (except on early production models), and manual/remote choke. Snow engine carburetors utilize both a primer and a choke for improved starting in cold temperatures.

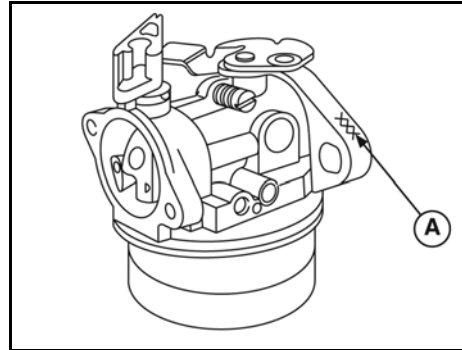


Figure 25

### Remove Carburetor



#### WARNING

Before servicing the carburetor or other fuel system components, drain all fuel from the tank and turn OFF the fuel valve (if equipped). Do not attempt to stop fuel flow by plugging the fuel hose.

1. Remove air cleaner assembly per Section 1. Discard the gasket.

**NOTE:** Snow engines do not have an air cleaner assembly. Remove the 1 or 2 piece shroud to gain access to the carburetor.

2. Move clamp and disconnect fuel hose from carburetor. Disconnect primer hose, if equipped.

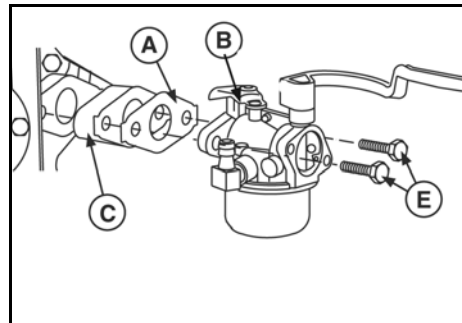


Figure 26

3. Remove two carburetor mounting screws or nuts (E, Figure 26).
4. Pull carburetor away from the adapter assembly (C) and rotate it to disengage

the governor link from the grommet on top of the throttle shaft lever (B). Discard gasket.

### Disassemble Carburetor

1. Remove the fixed main jet (bowl nut) and fiber washer, then remove the fuel bowl and the bowl gasket from the carburetor body. Discard the fiber washer and the gasket.
2. Remove the float hinge pin (C, Figure 27), float (A), and inlet needle (B). If the needle has a metal tip, also remove the soft needle seat in the carburetor body. Discard the hinge pin, inlet needle, and seat.

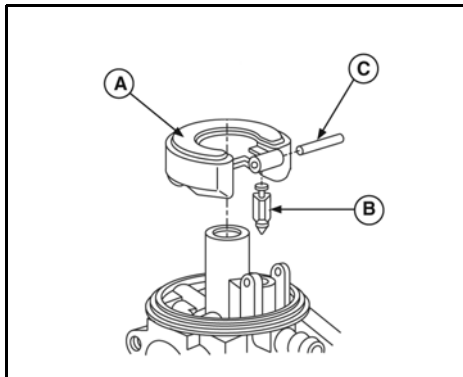


Figure 27

3. Remove idle speed screw with spring (B, Figure 28), if equipped.
4. Rotate throttle shaft (C) to the closed position. Remove throttle valve screws (F), then remove the throttle valve. Slide out the throttle shaft with the foam seal. Discard the seal.
5. Grasp choke valve and remove from choke shaft (A). Slide out choke shaft with the foam seal. Discard the seal.
6. With a modified pin punch (E), remove Welch plug(s) from carburetor body.

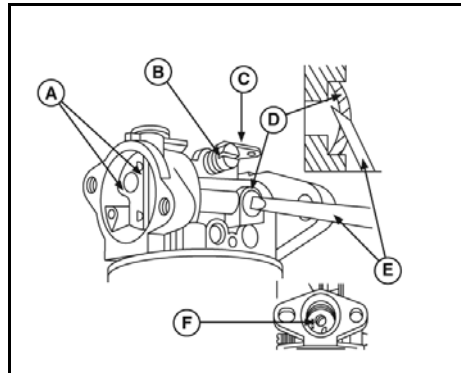


Figure 28

### Inspect and Clean Carburetor Components

1. Inspect openings in the carburetor body for evidence of wear or damage. If found, replace the entire carburetor assembly.
2. Inspect the choke shaft, choke valve, throttle shaft, and throttle valve for evidence of wear or damage. Replace parts as necessary.
3. Using Carb/Choke Cleaner #100041 or #100042, thoroughly clean the following components, then follow with compressed air to dry:
  - Passages in the fixed main jet (bowl nut)
  - Inside and outside of the fuel bowl
  - Float
  - Choke shaft and choke valve
  - Throttle shaft and throttle valve
  - All passages, openings, and the inside and outside of the carburetor body

**NOTE:** Do not soak non-metallic components, such as floats, o-rings, seals, or diaphragms, in carb/choke cleaner or they will be damaged.

4. If any passages remain plugged after cleaning, replace the component or the entire carburetor assembly.

### Assemble Carburetor

Consult the Illustrated Parts List to obtain the appropriate carburetor overhaul kit before reassembling the carburetor.

1. Install new Welch plug (A, Figure 29) with a pin punch (B) of slightly smaller diameter than the plug. Press against the plug until it is flat in the carburetor opening. Do not cave in the plug. Seal the

edge of the plug with a non-hardening sealant.

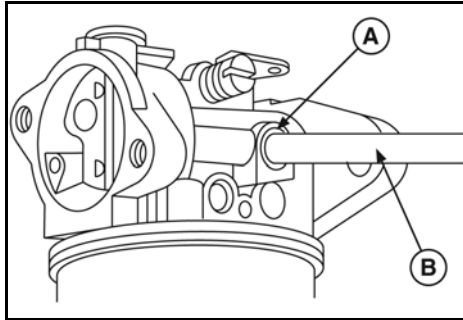


Figure 29

4

2. Install new foam seal (B, Figure 30) on choke shaft (E), then slide shaft into carburetor body (C). Rotate shaft clockwise (A), and insert choke valve into slot until centered, with dimples (D) positioned as shown. Actuate the choke shaft to check for proper movement.

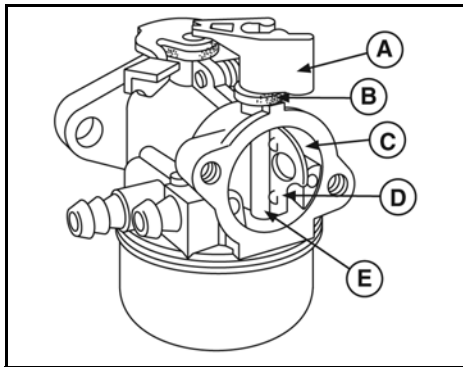


Figure 30

3. Install new foam seal (C, Figure 31) on throttle shaft (B), then slide shaft into carburetor body. Rotate shaft until flat is facing out. Position throttle valve on flat with numbers facing out (A), then install screws (D). Actuate the throttle shaft to check for proper movement.

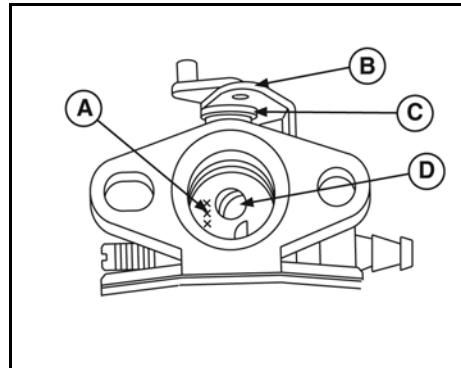


Figure 31

4. Install idle speed screw with spring, if equipped.
5. Using Bushing Driver #19057 (A, Figure 32), install new needle seat with grooved edge down (B) until firmly seated.

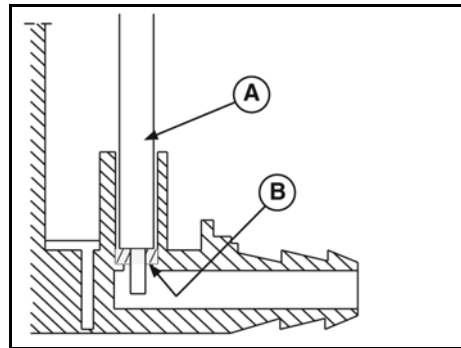


Figure 32

6. Install new inlet needle (B, Figure 33) on float (A), then position float in carburetor body. Secure with new hinge pin (C) and center the pin between the float bosses.

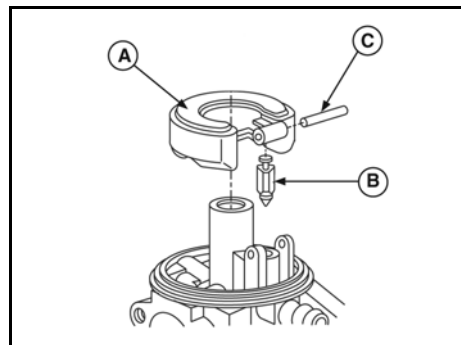


Figure 33

- Place new bowl gasket on carburetor body and install fuel bowl. Place new fiber washer on fixed main jet (bowl nut) and install. Torque to values listed in Section 12 - Engine Specifications.

### Install Carburetor

**NOTE:** Always replace air cleaner gaskets and carburetor mounting gaskets any time the carburetor has been removed for service.

- Hook z-bend of governor link into grommet on top of the throttle shaft lever.
- Place new gasket (A, Figure 34) between adapter (B) and carburetor (C).
- Position carburetor on control bracket and install screws or nuts (D). Torque to value listed in Section 12 - Engine Specifications.

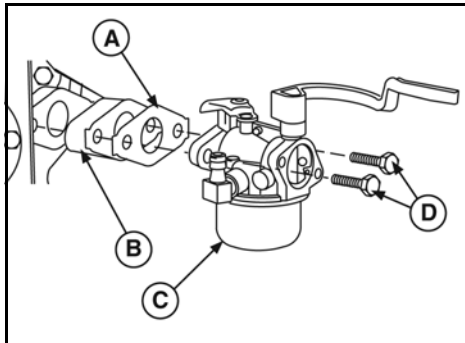


Figure 34

**NOTE:** Use new screws or apply Loctite® to original screws to prevent loosening from vibration.

- Connect fuel hose to carburetor and secure with clamp. Connect primer hose, if equipped.
- Using new gasket, install air cleaner assembly to carburetor per Section 1. Ensure breather hose is properly installed on the breather tube.

**NOTE:** For snow engines, install the 1 or 2 piece shroud.

- Adjust carburetor, if applicable, per Section 1.

## ReadyStart® Carburetor

### Vertical Model 120000

This carburetor utilizes a thermostatically controlled choke system, requiring no primer or manual choking when starting. The linkages installed in the carburetor are not individually serviceable, requiring replacement with a complete carburetor assembly.

### Remove Carburetor



#### WARNING

Before servicing the carburetor or other fuel system components, drain all fuel from the tank and turn OFF the fuel valve (if equipped). Do not attempt to stop the fuel flow by plugging the fuel hose.

4

- Remove air cleaner assembly per Section 1. Discard the gasket.
- Move clamp and disconnect fuel hose from carburetor.
- Remove two carburetor mounting screws (A, Figure 35).

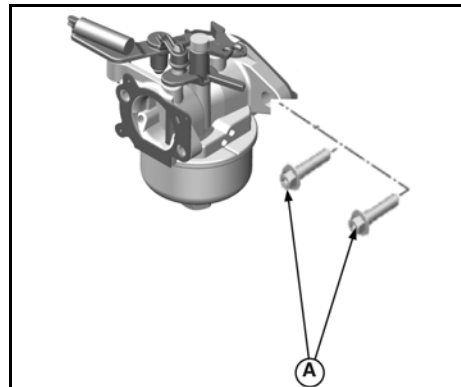


Figure 35

- Carefully remove carburetor from control bracket. Rotate the carburetor to disconnect the choke link, spring, and governor link.

- Remove gasket (A, Figure 36), spacer, and o-ring between control bracket and carburetor (B).

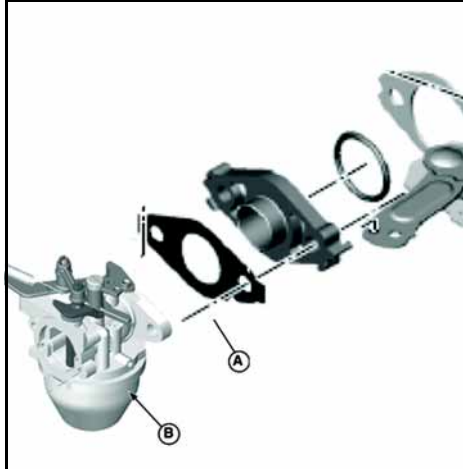


Figure 36

#### Disassemble Carburetor

- Remove the fixed main jet (bowl nut) (A, Figure 37) and fiber washer (B), then remove the fuel bowl (C) and the bowl gasket (D) from the carburetor body. Discard the fiber washer and the gasket.
- Remove the float hinge pin (E), float (F), and inlet needle (G). Discard the hinge pin, and inlet needle.

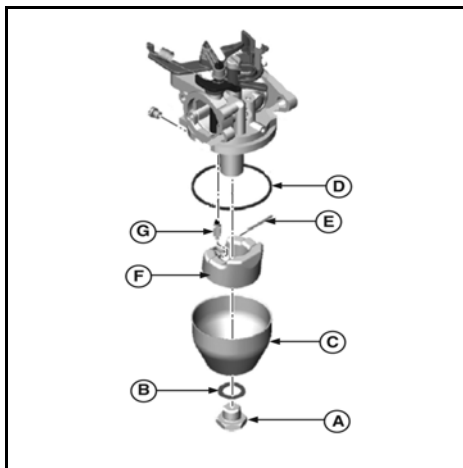


Figure 37

**NOTE:** Do not disassemble the carburetor body or linkages.

#### Inspect and Clean Carburetor

- Inspect openings in the carburetor body for evidence of wear or damage. If found, replace the entire carburetor assembly.
- Inspect the choke shaft, choke valve, throttle shaft, and throttle valve for evidence of wear or damage. If found, replace the entire carburetor assembly.
- Using Carb/Choke Cleaner #100041 or #100042, clean inside and outside surfaces of carburetor, then follow with compressed air to dry.

**NOTE:** Do not soak the carburetor in carb/choke cleaner or it will be damaged.

- If any passages remain plugged after cleaning, replace the entire carburetor assembly.

#### Assemble Carburetor

Consult the Illustrated Parts List to obtain the appropriate carburetor overhaul kit before reassembling the carburetor.

**NOTE:** Always replace air cleaner gaskets and carburetor mounting gaskets any time the carburetor has been removed for service.

- Install new hinge pin (E, Figure 38), float (F), and new inlet needle (G).
- Install new bowl gasket (D) with the fuel bowl (C). Replace the fiber washer (B) and install the fixed main jet (A).

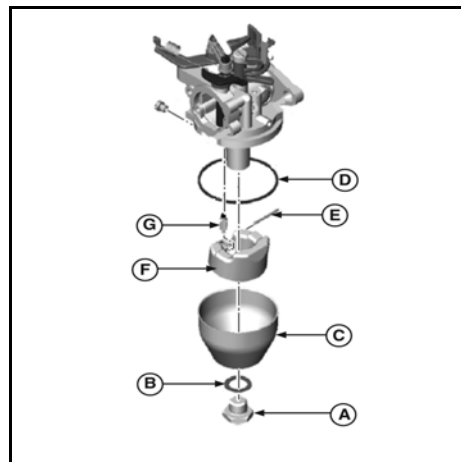


Figure 38

3. Place new gasket (A, Figure 39), spacer, and new o-ring between control bracket (B) and carburetor (C).
4. Position carburetor on control bracket and install screws. Torque to value listed in Section 12 - Engine Specifications.

**NOTE:** Use new screws or apply Loctite® to original screws to prevent loosening from vibration.

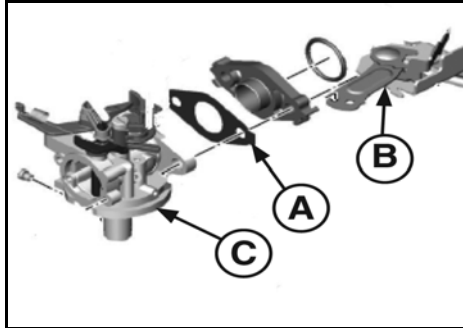


Figure 39

5. Connect fuel hose to carburetor and secure with clamp.
6. Using new gasket, install air cleaner assembly to carburetor per Section 1. Adjust carburetor, if applicable, per Section 1.

## LMT Carburetor

### Horizontal and Vertical Models 200000, 210000, 280000, 310000, 330000

Two versions of this carburetor have been used (Figures 40 and 41).

These carburetors have a fixed high speed main jet with a screw for idle mixture and idle speed adjustment. The letters LMT are cast into the body of the carburetor while the identification numbers are stamped into the carburetor mounting flange next to the idle mixture screw or above the fuel inlet.

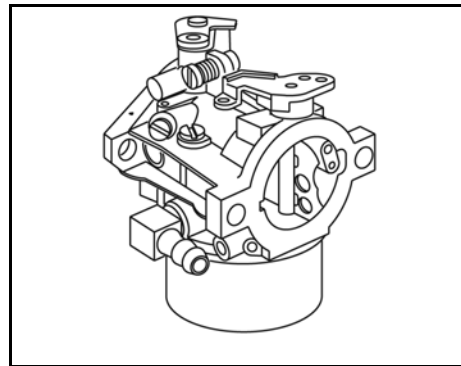


Figure 40

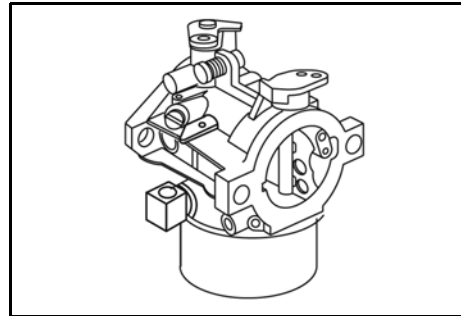


Figure 41

4



#### WARNING

Before servicing the carburetor or other fuel system components, drain all fuel from the tank and turn OFF the fuel valve (if equipped). Do not attempt to stop the fuel flow by plugging the fuel hose.



### Remove Carburetor

1. Disconnect wire(s) from the carburetor solenoid. Two styles of solenoids have been used (Figure 42).

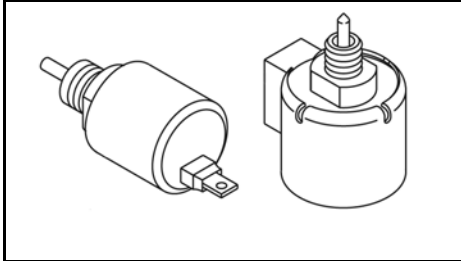


Figure 42

2. Remove air cleaner assembly per Section 1. Discard the gasket.
3. Move clamp and disconnect hose from carburetor.
4. Remove two carburetor screws or nuts while holding carburetor.
5. Carefully rotate carburetor to disconnect throttle (A, Figure 43) and spring (B) and the choke link during removal.

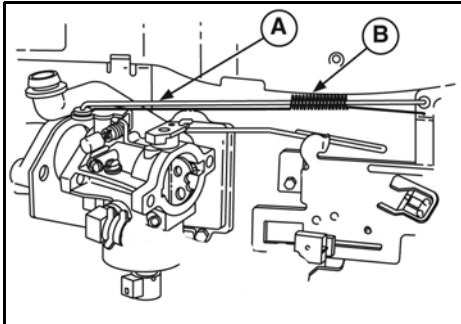


Figure 43

### Disassemble Carburetor

1. Remove solenoid and solenoid washer. Discard washer. Remove float bowl and float bowl gasket from carburetor. Discard gasket.
2. Using Carburetor Nozzle Screwdriver #19280, remove the main carburetor emulsion tube (A, Figure 44).

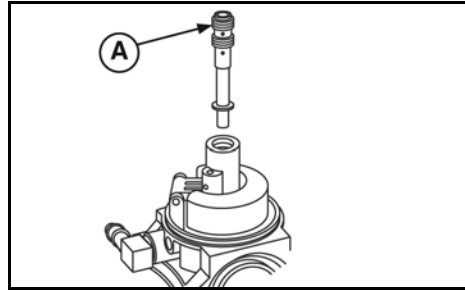


Figure 44

3. Remove float hinge pin, float, and inlet needle. Discard the hinge pin and inlet needle.
4. Screw a 1/4-20 tap into fuel inlet seat 3-4 turns and remove.
5. Place a hex nut (A, Figure 45) and washer (B) on a 1/4-20 screw. Place 1/4" drive 3/8" socket (C) over fuel inlet seat.
6. Thread screw into tapped inlet seat until screw bottoms. Thread nut down to washer and continue turning nut until inlet seat is free from carburetor body.

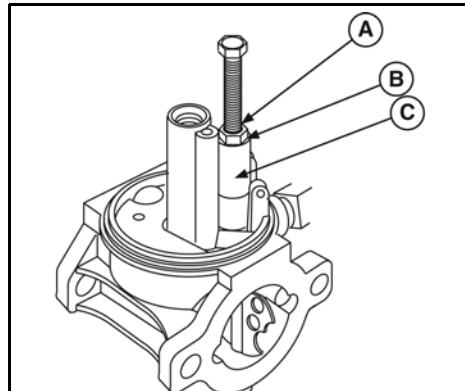


Figure 45

7. Remove idle mixture limiter cap, when used, then remove idle mixture screw with spring and idle speed screw with spring.
8. Rotate throttle shaft to closed position and remove throttle valve screws and throttle valve.
9. Remove throttle shaft, foam seal, and throttle shaft seal from carburetor body. Discard seals.
10. If carburetor is equipped with a plastic choke shaft, rotate choke shaft to wide

open position, then pull choke valve out of choke shaft. Remove choke shaft, return spring (when used), and foam seal. Discard seal.

**- OR -**

If carburetor is equipped with a metal choke shaft, rotate choke shaft to closed position. Remove two choke valve screws and choke valve. Remove choke shaft, return spring and foam seal. Discard seal.

11. With a modified pin punch (A, Figure 46) remove welch plug (B) from carburetor body.

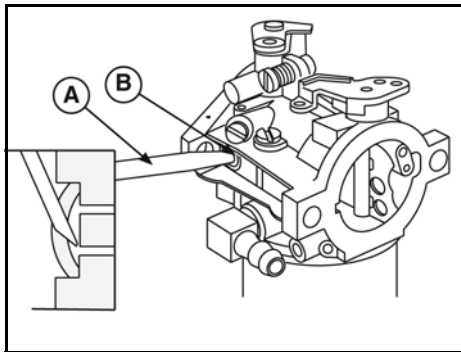


Figure 46

**NOTE:** Do not attempt to remove the pilot jets, which are pressed in and not serviceable.

**Inspect and Clean Carburetor**

1. Inspect openings in the carburetor body for evidence of wear or damage. If found, replace the entire carburetor assembly.
2. Inspect the choke shaft, choke valve, throttle shaft, and throttle valve for evidence of wear or damage. Replace parts as necessary.
3. Using Carb/Choke Cleaner #100041 or #100042, thoroughly clean the following components, then follow with compressed air to dry:
  - Passages in the fixed main jet (bowl nut) or emulsion tube
  - Inside and outside of the fuel bowl
  - Float
  - Choke shaft and choke valve
  - Throttle shaft and throttle valve
  - All passages, openings, and the inside and outside of the carburetor body

**NOTE:** Do not soak non-metallic components, such as floats, o-rings, seals, or diaphragms, in carb/choke cleaner or they will be damaged.

4. If any passages remain plugged after cleaning, replace the component or the entire carburetor assembly.

**Assemble Carburetor**

Consult the Illustrated Parts List to obtain the appropriate carburetor overhaul kit before reassembling the carburetor.

1. Install new welch plug (A, Figure 47) with pin punch (B) of slightly smaller diameter than the plug. Press against the plug until it is flat in the carburetor opening. Do not cave in plug. Seal the edge of the plug with non-hardening sealant.

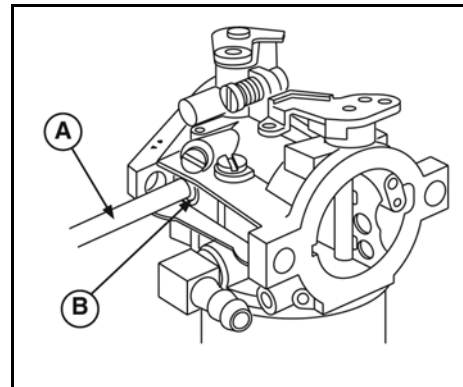


Figure 47

2. If carburetor is equipped with a metal choke shaft,
  - Install new foam seal and return spring (C, Figure 48) on choke shaft, hooking small hook (A) in notch on choke lever (D).
  - Insert choke shaft assembly into carburetor body and engage large end of return spring (E) on boss. If carburetor has detent spring, guide spring into slot in choke shaft lever (B).
  - Place choke valve (F) on shaft and install screws, then actuate the choke shaft to check for proper movement.

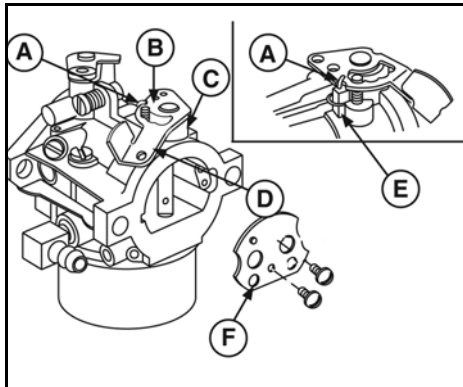


Figure 48

4

- OR -

3. If carburetor is equipped with a plastic choke shaft,
  - Install new foam seal and return spring on choke shaft (C, Figure 49) with straight end of spring against choke shaft lever (B).
  - Insert choke shaft assembly into carburetor body and engage large end of return spring on anchor pin or boss (A). Lift choke slightly and turn counterclockwise until stop on lever clears anchor pin or boss, then push shaft down.

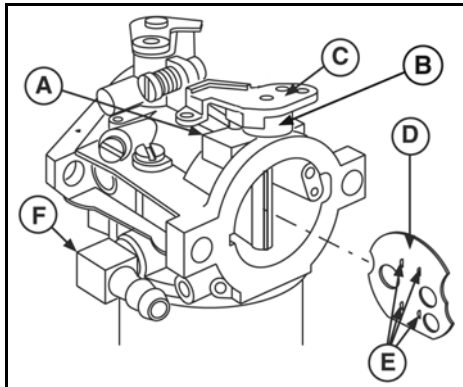


Figure 49

- Insert choke valve (D) into choke shaft with dimples (E) toward fuel inlet side of carburetor. Actuate the choke shaft to check for proper movement.

4. Install new throttle shaft seal (C, Figure 50) with sealing lip down in carburetor body until top of seal is flush with top of carburetor (D). Install new foam seal (B) on throttle shaft, then slide shaft into carburetor body. Rotate shaft until flat is facing out. Position throttle valve (E) on flat with numbers facing out, then install screws. Actuate the throttle shaft to check for proper movement.

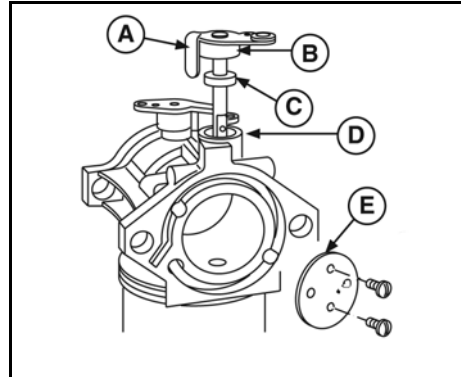


Figure 50

5. Install idle speed screw and spring, then install idle mixture screw with spring and turn until head of screw touches spring.
6. Using Knockout Pin #19135, press new fuel inlet seat (A, Figure 51) until flush with fuel inlet boss (B).

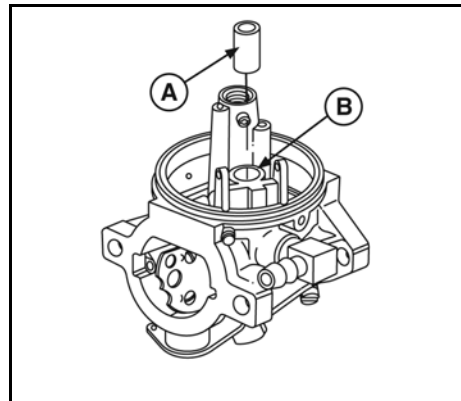


Figure 51

7. Insert new inlet needle in slot on float, then position float in carburetor body. Secure with new hinge pin and center the pin between the float bosses.

8. Install emulsion tube using Carburetor Screwdriver #19280 until tube seats (A, Figure 52).

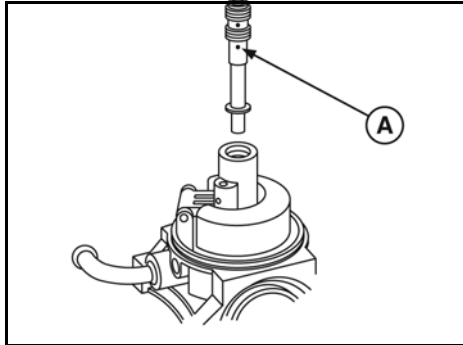


Figure 52

9. Place new bowl gasket on carburetor body and install fuel bowl. Place new washer on solenoid and install.
10. After installing emulsion tube, use compressed air to blow out any chips or debris that may have been loosened while installing tube.

**NOTE:** On Model Series 280000, 310000, 330000, install main jet after installing emulsion tube.

#### Install Carburetor

**NOTE:** Always replace air cleaner gaskets and carburetor mounting gaskets any time the carburetor has been removed for service.

1. Position new gasket on studs with long edge of gasket opposite fuel inlet of carburetor.
2. Hook governor spring (B, Figure 53) in throttle lever hole without grommet. Hook governor link (A) in throttle lever hole with grommet.

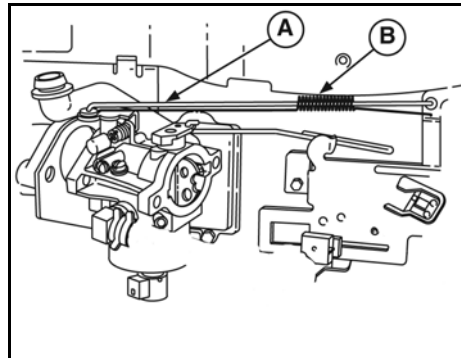


Figure 53

3. Hook choke link into outer hole of choke shaft from underneath. Slide other end of choke link into slot in governor control bracket.
4. Position carburetor on engine. Install screws or nuts and torque to values listed in Section 12 - Engine Specifications.
5. Connect fuel hose to carburetor and secure with hose clamp.
6. Using new gasket, install air cleaner assembly to carburetor per Section 1. Adjust carburetor, if applicable, per Section 1.
7. After final carburetor adjustment (last step below), use Knockout Pin #19135 (A, Figure 54) to install new limiter cap (B) with flat side facing up.

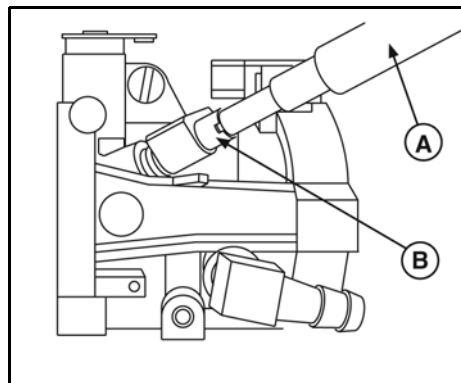


Figure 54

4

## Nikki Carburetor

### Vertical Models 280000, 310000, 330000



#### WARNING

Before servicing the carburetor or other fuel system components, drain all fuel from the tank and turn OFF the fuel valve (if equipped). Do not attempt to stop the fuel flow by plugging the fuel hose.

#### Remove Carburetor

1. Disconnect the wire from the carburetor solenoid (E, Figure 55).
2. Remove air cleaner assembly per Section 1. Discard gasket.
3. Move clamp and disconnect fuel hose from carburetor.
4. Remove two carburetor screws or nuts while holding the carburetor.
5. Carefully rotate the carburetor to disengage the choke linkage (C), governor link (A), and governor link spring (B).

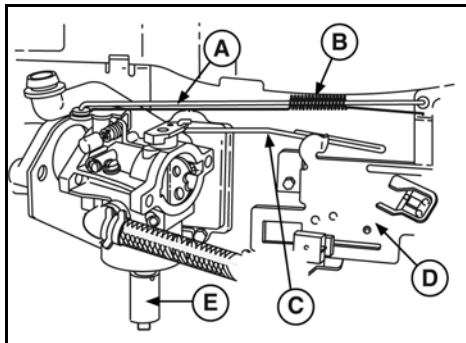


Figure 55

#### Disassemble Carburetor

1. Remove fuel bowl screws (A, Figure 56). Remove the fuel bowl (B) from the carburetor body.

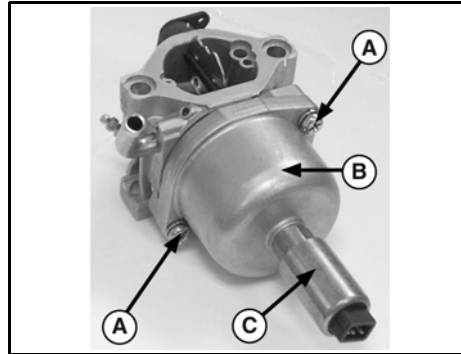


Figure 56

**NOTE:** There is a spring between the fuel bowl and the float assembly. Use caution when removing the fuel bowl to avoid losing the spring.

2. Remove the solenoid (C) from the fuel bowl. Discard gasket.
3. Remove the fuel transfer tube (B) from the carburetor base (A, Figure 57). Discard o-rings.
4. Pull the hinge pin (C) from the float assembly. Separate the float and inlet needle. Discard the hinge pin and inlet needle.

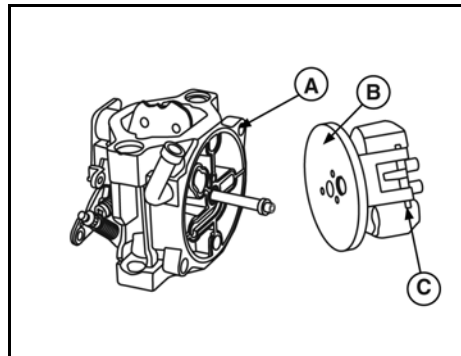


Figure 57

5. Remove the float bowl gasket (D, Figure 58) from the carburetor body. Discard the gasket.

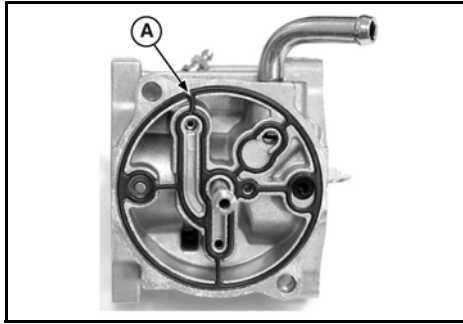


Figure 58

6. If equipped, remove the idle mixture screw with spring (A, Figure 59) and the idle speed screw with spring (B).

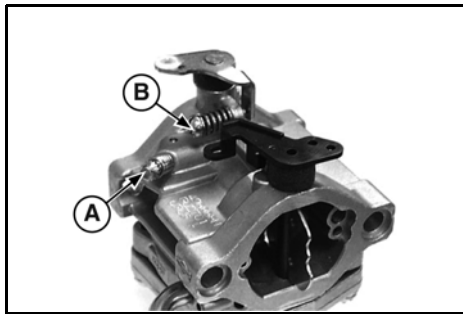


Figure 59

7. Rotate the throttle shaft to the closed position (Figure 60). Remove two screws (A) and the throttle plate.

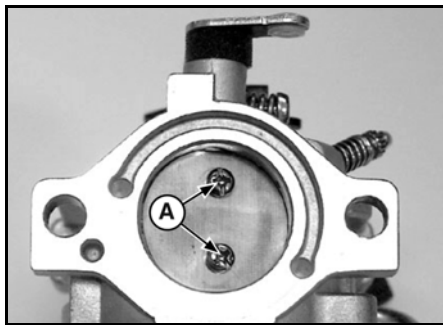


Figure 60

8. Pull the throttle shaft from the carburetor body. Discard foam seals.
9. Rotate the choke shaft to the wide open position (Figure 61), then pull the choke plate (B) from the shaft (A).

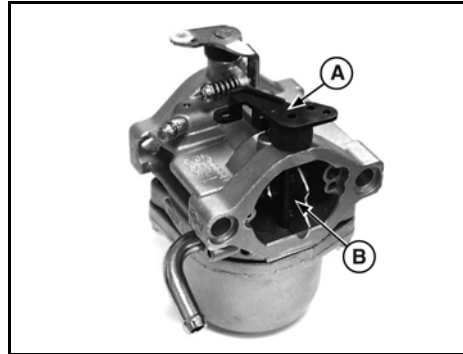


Figure 61

10. Remove the choke shaft, return spring, and foam seal. Discard spring and seal.
11. Remove the main jet and seal.

**NOTE:** Do not attempt to remove the pilot jets, which are pressed in and not serviceable.

12. Remove the welch plug (A, Figure 62) from the carburetor with a modified pin punch. Discard the welch plug.

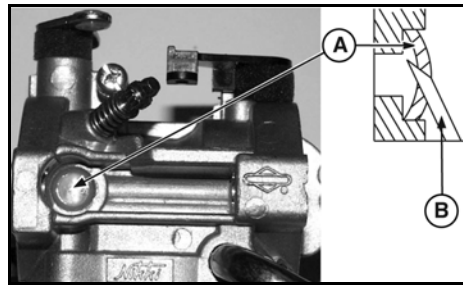


Figure 62

#### Inspect and Clean Carburetor

1. Inspect openings in the carburetor body for evidence of wear or damage. If found, replace the entire carburetor assembly.
2. Inspect the choke shaft, choke valve, throttle shaft, and throttle valve for evidence of wear or damage. Replace parts as necessary.
3. Using Carb/Choke Cleaner #100041 or #100042, thoroughly clean the following components, then follow with compressed air to dry:
  - Passages in the fuel transfer tube and jets
  - Inside and outside of the fuel bowl
  - Float

- Choke shaft and choke valve
- Throttle shaft and throttle valve
- All passages, openings, and the inside and outside of the carburetor body

**NOTE:** Do not soak non-metallic components, such as floats, o-rings, seals, or diaphragms, in carb/choke cleaner or they will be damaged.

4. If any passages remain plugged after cleaning, replace the component or the entire carburetor assembly.

#### Assemble Carburetor

1. Install new welch plug with pin punch of slightly smaller diameter than the plug. Press against the plug until it is flat in the carburetor opening. Do not cave in the plug. Seal the edge of the plug with a non-hardening sealant.
2. Reinstall main jet and seal
3. Install new seal and spring on the choke shaft with the top of the spring contacting the choke shaft lever (B, Figure 63).

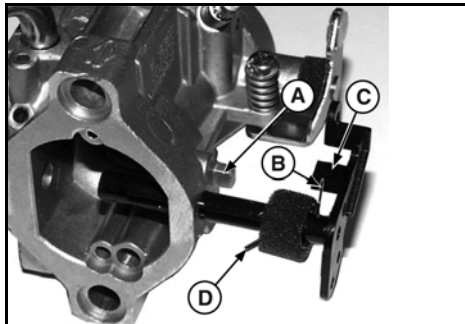


Figure 63

4. Turn the choke shaft counterclockwise while gently pushing it into the carburetor body until the bottom end of the spring (D) rests on the back of the spring perch (A).
5. Lift the choke shaft up slightly and continue turning counterclockwise until the stop on the lever clears the spring perch. Push the shaft inward. When released, the choke shaft lever should rest on the spring perch as shown (Figure 64).

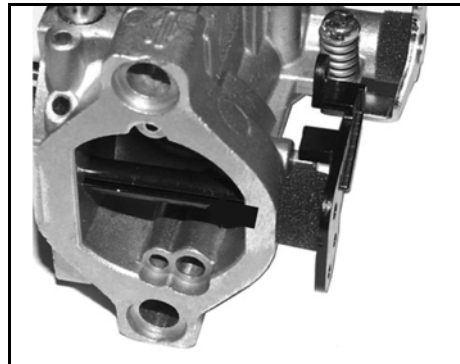


Figure 64

6. Insert the choke plate into the choke shaft with the dimples toward the fuel inlet side of the carburetor. Dimples center the choke plate on the shaft (A, Figure 65).

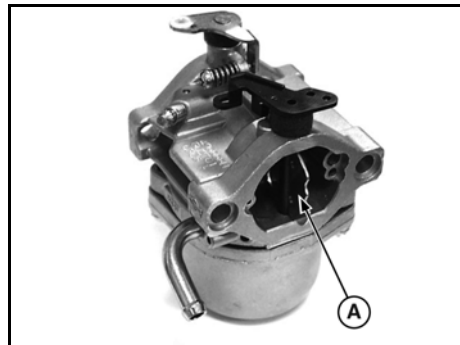


Figure 65

7. Install foam washer (B) to throttle shaft (A, Figure 66). Install throttle shaft to the carburetor body. Turn throttle shaft until flat is facing out.
8. Lay the throttle plate (C) on the flat of the shaft. Install two screws (D).

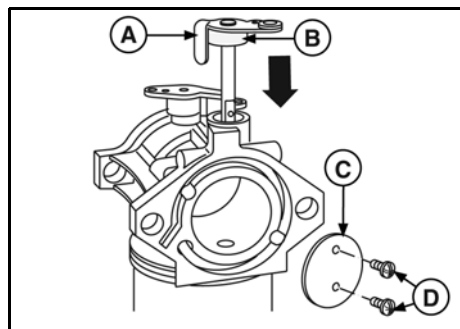


Figure 66

**NOTE:** The holes in the throttle plate are offset. If the throttle plate is installed incorrectly, it will not close.

9. If equipped, install idle mixture screw with spring and the idle speed screw with spring. Turn each screw until the head of the screw touches the spring.
10. Insert new inlet needle (B) into the slot on the float (A, Figure 67).
11. Place the needle and float assembly into the fuel transfer tube. Secure with new hinge pin (C) and center the pin between the float bosses.

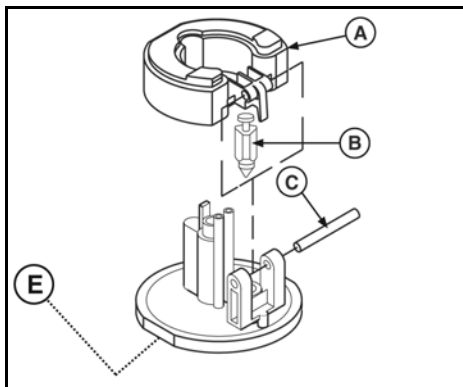


Figure 67

12. Install new o-ring on fuel transfer tube (E).
13. Place new float bowl gasket (A, Figure 68) on the carburetor body, then press the fuel transfer tube (B, Figure 69) onto the carburetor base (C).

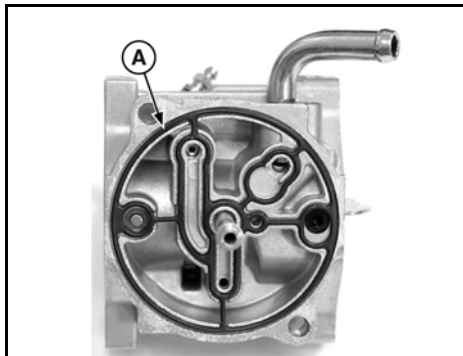


Figure 68

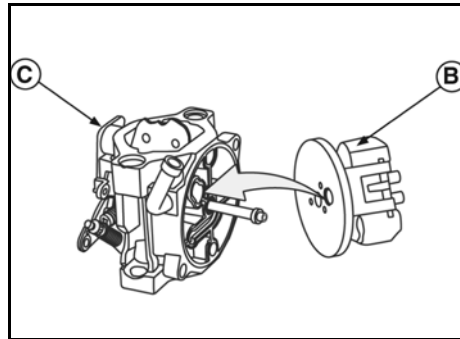


Figure 69

**NOTE:** The locating tang on the fuel transfer tube MUST be placed in the recess of the carburetor base as shown.

14. Insert the spring (A, Figure 70) to the bottom of the float assembly. Place the fuel bowl on the carburetor base, and fasten with screws. Torque screws per values listed in Section 12 - Engine Specifications.

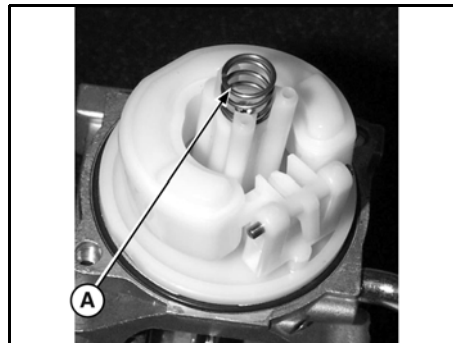


Figure 70

15. Install solenoid with new gasket. Torque solenoid to values listed in Section 12 - Engine Specifications.

#### Install Carburetor

1. Place new gasket between carburetor and manifold with long edge of gasket opposite the fuel inlet.
2. Hook governor link spring (B, Figure 71) in non-grommet throttle lever hole.
3. Hook governor link (A) in grommet throttle lever hole. Link fits over top of lever.

4



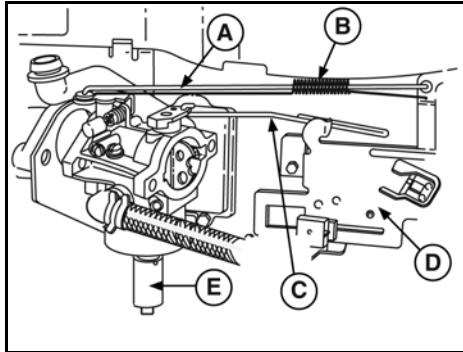


Figure 71

4

4. Hook choke link (C) into hole in choke lever.
5. Position carburetor on manifold and install screws or nuts by hand.
6. Actuate choke and throttle linkages to ensure proper movement, then tighten screws per values listed in Section 12 - Engine Specifications.
7. Attach fuel hose to carburetor and secure with hose clamp.
8. Using new gasket, install air cleaner assembly per Section 1.
9. Connect wires to solenoid (E).
10. Adjust carburetor and/or governor settings per Section 1.

### Nikki LP/NG Mixer

#### Vertical Model 310000 Gaseous Fuel

Briggs & Stratton utilizes the Nikki Gaseous Fuel Mixer on some of the 310000-Series Single-Cylinder OHV engines. The mixer is not serviceable, thus requiring replacement with a complete assembly.

## SECTION 5 - GOVERNOR SYSTEMS

---

LINKAGE AND SPRING ORIENTATION .....	-88
GOVERNED RPM LIMITS .....	-89
GOVERNOR SERVICE .....	-89
HORIZONTAL MODELS 110000, 120000, 150000, 200000 .....	89
VERTICAL MODELS 97700, 99700, 110000, 120000, 210000, 280000, 310000, 330000 .....	91

## GOVERNOR SYSTEMS

### Linkage and Spring Orientation

**NOTE:** Be sure to note hole position of linkage before removing.

- Figure 1 - Horizontal Shaft Models 110000, 120000, 150000, 200000, 210000.
- Figure 2 - Vertical Shaft Model 97700
- Figure 3 - Vertical Shaft Model 99700
- Figure 4 - Vertical Shaft Models 110000, 120000, 210000 (Primer Carburetors).
- Figure 5 - Vertical Shaft Models 110000, 120000, 210000 (Choke-A-Matic® Carburetors).
- Figure 6 - Models 280000, 310000, 330000 (Choke-A-Matic® Carburetors).
- Figure 7 - Models 280000, 310000, 330000 (Manual Friction).
- Figure 8 - Models 280000, 310000, 330000 (Manual Choke).

5

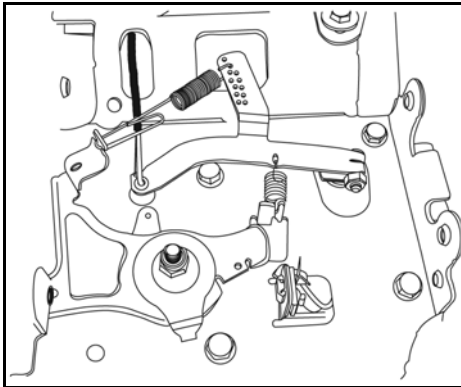


Figure 1

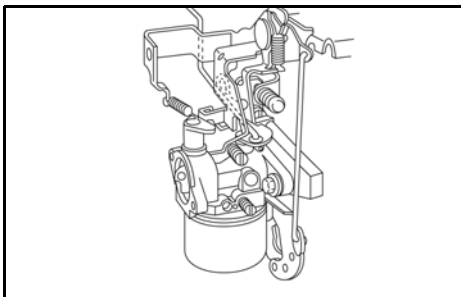


Figure 2

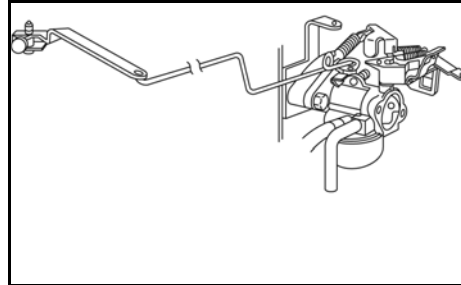


Figure 3

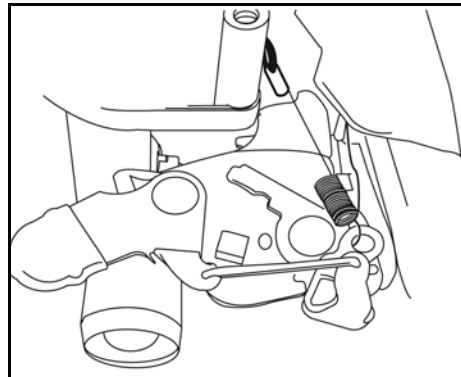


Figure 4

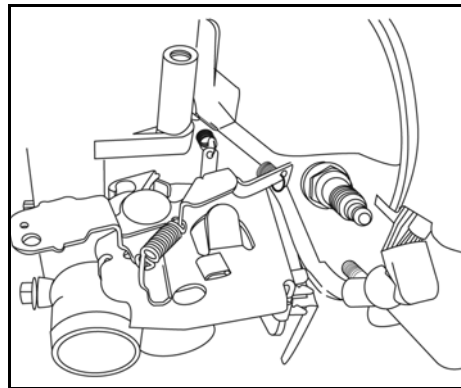


Figure 5

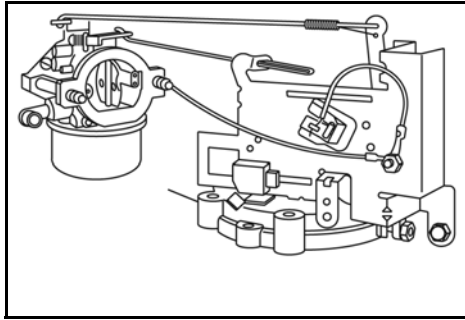


Figure 6

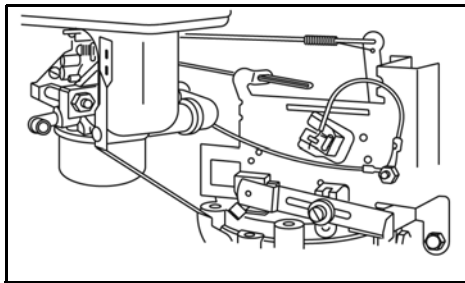


Figure 7

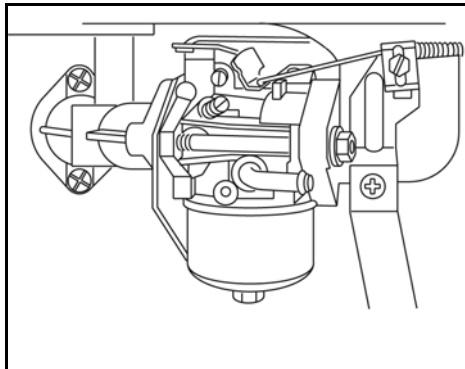


Figure 8

### Governed RPM Limits

To comply with specified top governed speed limits, Briggs & Stratton supplies engines with an adjustable top speed limit, which the equipment manufacturers set to their own specifications.

Top governed speed should be checked with a tachometer when the engine is operating on a completely assembled unit. The equipment should be operated under no load when making these checks.

If a governor spring must be replaced, consult the appropriate Illustrated Parts List for the correct part number.

After a new governor spring is installed, check the engine top governed speed with an accurate tachometer, as noted above, and adjust as required.

### Governor Service

#### Horizontal Models 110000, 120000, 150000, 200000, 210000

The mechanical governor is part of the crankcase cover. The governor gear (A, Figure 9) is driven by the crankshaft timing gear (B) through an idler gear (C). The governor crank (D) is mounted in the cylinder assembly.

**NOTE:** Stamped side of idler gear faces out.

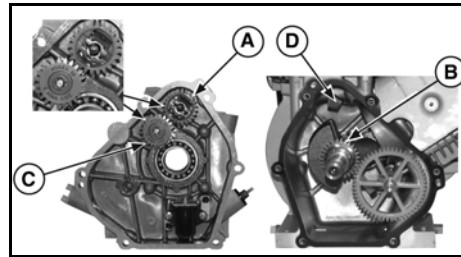


Figure 9

### Disassemble

1. Drain oil from engine. Remove burrs and clean crankshaft, then remove crankcase cover. Set aside.
2. Loosen governor lever nut (A, Figure 10).
3. Slide lever off governor crank (B) and disconnect from governor link (C).
4. Remove push nut and washer (D) from governor crank. Remove any burrs from governor crank, and then remove crank from inside cylinder.

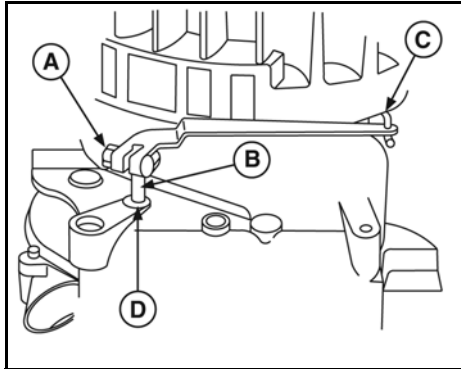


Figure 10

### Inspect Governor

1. Check governor gear assembly for worn weight pins, worn or damaged governor cup, and chipped or damaged teeth.
2. If wear or damage is found, remove the governor gear by carefully prying it off the spindle with two flat-bladed screw drivers (A, Figure 11). Discard the washer at the base of the spindle.

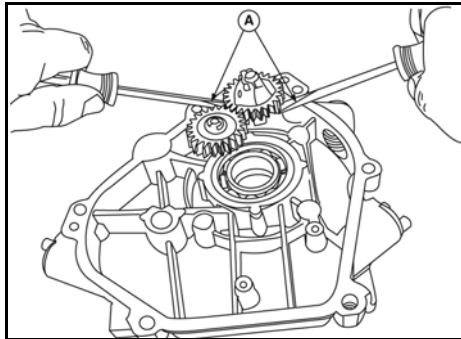


Figure 11

3. Install new washer on spindle, then carefully press new governor gear assembly on spindle until fully seated.
4. Check idler gear for wear or damage. If found, remove retainer clip and gear, then install new gear.
5. Check governor crank for wear or damage. Replace if necessary.

### Assemble

1. Install governor crank from inside cylinder. Slide washer (when used) on crank and install new push nut.

2. Slide the governor lever on crank and finger-tighten bolt and nut until crank turns with a slight resistance.
3. Rotate crank until paddle is aligned with cup on governor gear assembly.
4. Install new crankcase cover gasket(s) of same thickness as originally removed from cylinder.
5. Place seal protector in oil seal and slide cover over crankshaft until it seats.

**NOTE:** It may be necessary to rotate crankshaft to engage idler gear with timing gear.

6. Install cover or sump screws in order shown in Figure 12. Torque to values listed in Section 12 - Engine Specifications.

7. Adjust governor system per Section 1.

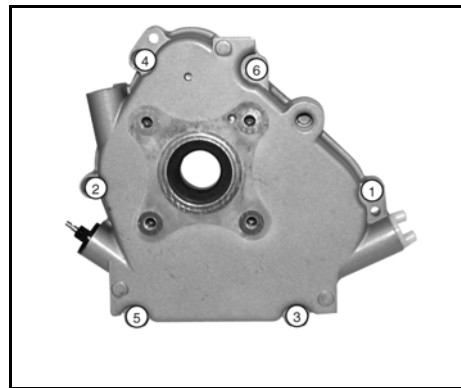


Figure 12

**Vertical Models 97700, 99700, 110000,  
120000, 210000, 280000, 310000,  
330000**

The mechanical governor is part of the oil slinger assembly (A, Figure 13) attached to the camshaft. The governor crank is mounted in the cylinder assembly.

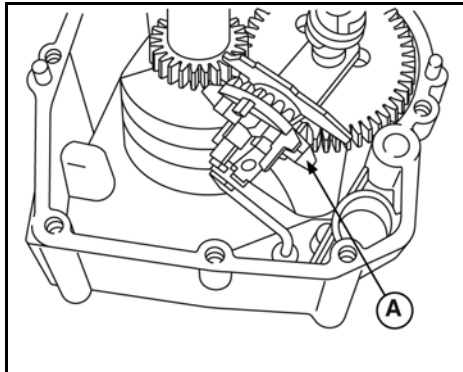


Figure 13

**Disassemble**

1. Drain oil from engine.
2. Loosen governor lever nut (A, Figure 14, Figure 15).

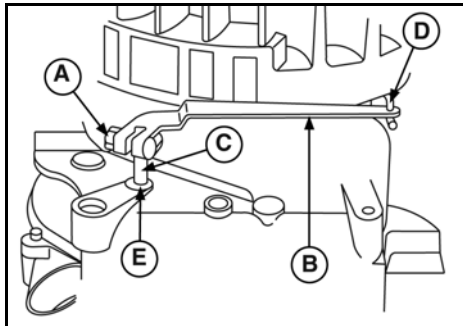


Figure 14

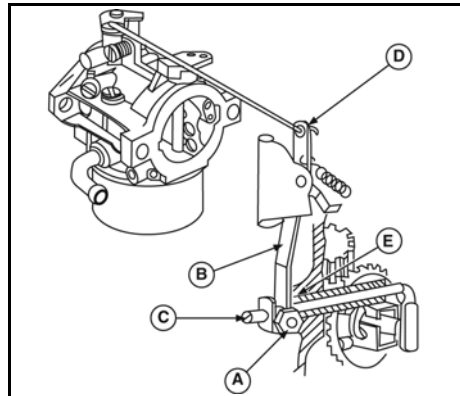


Figure 15

3. Slide lever (B) off governor crank (C) and disconnect from governor link (D).
4. Remove push nut or clip and washer (E) from governor crank. Remove burrs from governor crank, and remove crank from inside cylinder.
5. Remove governor crank seal in cylinder, if equipped.

**5**

**Inspect Governor**

1. Check governor gear/oil slinger assembly for worn weight pins, worn or damaged governor cup, and chipped or damaged teeth on paddles of oil slinger.
2. If wear or damage is found, replace the governor gear/oil slinger assembly.
3. Check governor crank for wear or damage. Replace if necessary.

**Assemble Governor**

1. Install new governor crank seal in cylinder, if equipped.
2. Install governor crank from inside cylinder. Slide washer (when used) on crank and install new push nut or clip.
3. Slide governor lever on crank and finger-tighten bolt and nut until crank turns with slight resistance.
4. Rotate crank until paddle contacts cup on governor gear/oil slinger assembly.
5. Install new sump gasket(s) of same thickness as originally removed from cylinder.

6. Place seal protector in oil seal and slide sump over crankshaft until it seats.

**NOTE:** It may be necessary to rotate crankshaft and cam gear to get oil pump (if equipped) to engage oil pump drive slot in cam gear.

7. Install sump screws in order shown in Figure 16 and Figure 17. Torque to values listed in Section 12 - Engine Specifications.

**NOTE:** The screw at position four or position nine (Figure 16 or Figure 17) was factory coated with sealant. Coat screw with a non-hardening sealant, such as Permatex® 2 or equivalent, before installing.

8. Adjust governor system per Section 1.

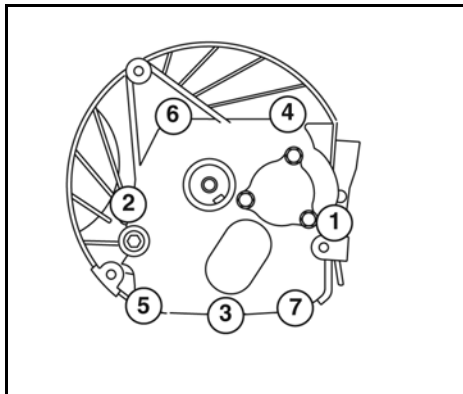


Figure 16

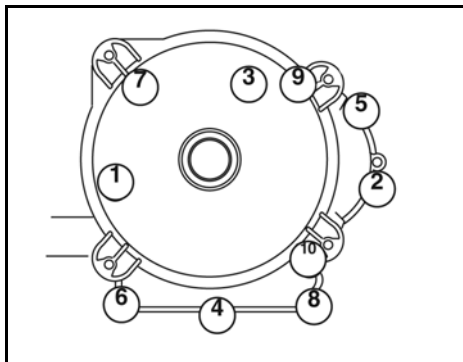


Figure 17

5

## SECTION 6 - CYLINDER HEAD AND VALVES

---

<b>SERVICE CYLINDER HEAD</b> .....	<b>-94</b>
HORIZONTAL AND VERTICAL MODELS 97700, 99700, 110000, 120000, 150000 .....	94
<b>SERVICE CYLINDER HEAD</b> .....	<b>-99</b>
HORIZONTAL AND VERTICAL MODELS 200000, 210000, 280000, 310000, 330000 .....	99



## CYLINDER HEADS AND VALVES

Before the cylinder head can be removed, other external parts must be removed, such as the air cleaner, fuel tank, oil fill tube, blower housing, muffler, carburetor, control bracket assembly, and intake manifold.

### Remove Cylinder Head

#### Horizontal and Vertical Models 97700, 99700, 110000, 120000, 150000

1. Remove four screws (A, Figure 1 or 2) from rocker cover, then remove cover and gasket.

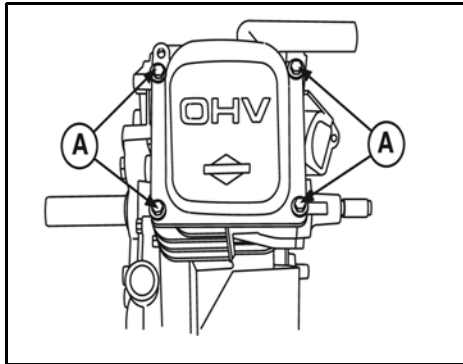


Figure 1

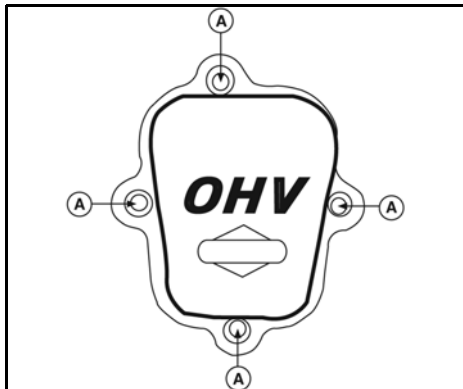


Figure 2

2. Remove cylinder head screws (Figures 3, 4, 5, 6), then remove head and gasket from cylinder.

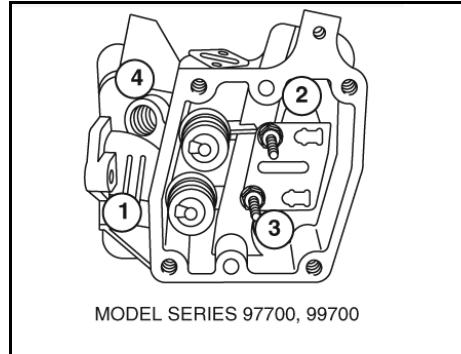


Figure 3

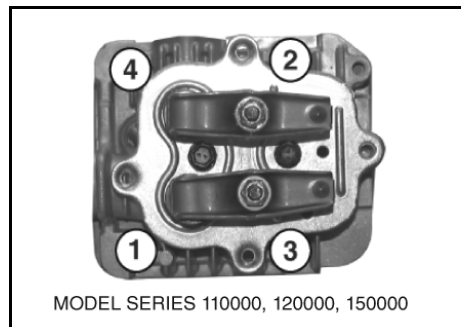


Figure 4

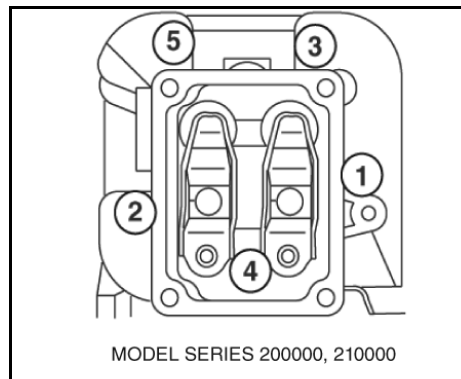


Figure 5

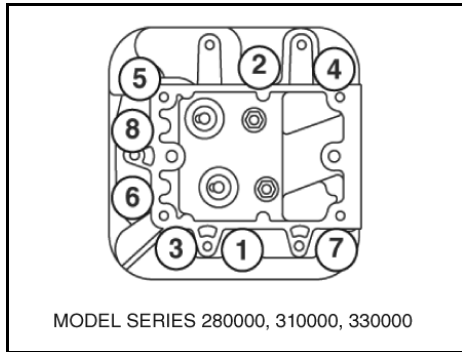


Figure 6

3. Remove push rods one at a time, marking the location and orientation of each for proper installation later.
4. Using a plastic scraping tool, carefully clean all traces of head gasket from the head and cylinder mating surfaces.

#### Disassemble Cylinder Head

1. Loosen rocker arm screws and/or lock nuts (A, Figure 7 and 8), and remove from rocker arm studs. Remove rocker arms (B) and rocker balls from studs.

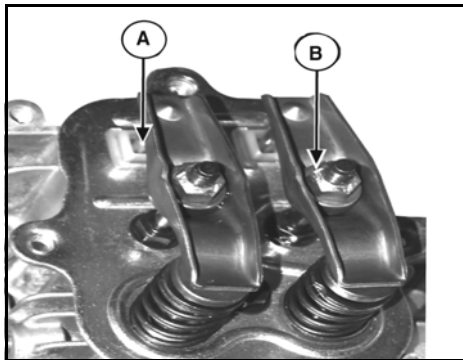


Figure 7

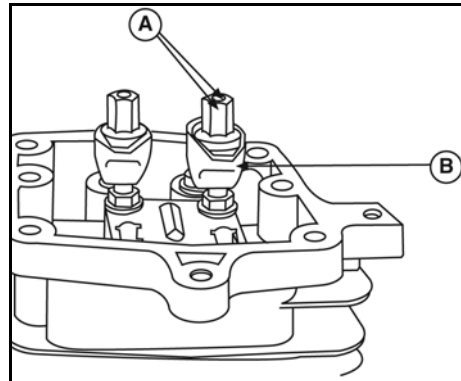


Figure 8

2. Remove valve stem caps (A, Figure 9) (if used), the rocker arm studs, and the push rod guide (models 97700, 99700).
3. Using thumbs, press down on each valve spring retainer and disengage retainer from valve stem (B). Remove retainers, springs, valves, and intake valve stem seal/washer, if equipped.

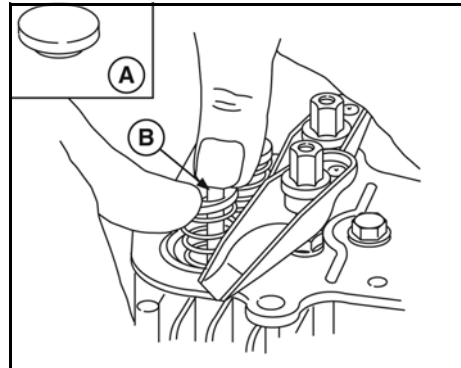


Figure 9

4. Remove push rod cylinder head plate and plate gasket (models 110000, 120000, 150000). Remove and discard the plastic push rod guides from the head plate.

#### Inspection

1. Visually inspect head for cracks, excessive heat discoloration, warping of the cylinder or rocker cover mating surfaces, and burned or damaged valve seats. Replace head, if any of these problems are found.

6

- If head passes visual inspection, use Plug Gauge #19122 to check valve guides for wear. If gauge enters the guide 1/4" (6.4 mm) or more, replace the guide (models 97700, 99700) or replace the entire head (models 110000, 120000, 150000). If plug gauge is not available, see Section 12 - Engine Specifications for the valve guide reject dimension.

**NOTE:** To replace valve guides (models 97700, 99700), use Valve Guide Driver #19367 (A, Figure 10) to press out the guides. Then, using the same tool, press either end of the new guides into the head until 1/8" (3.2 mm) above flush (A, Figure 11).

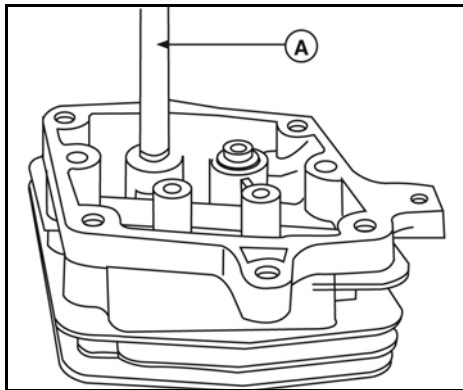


Figure 10

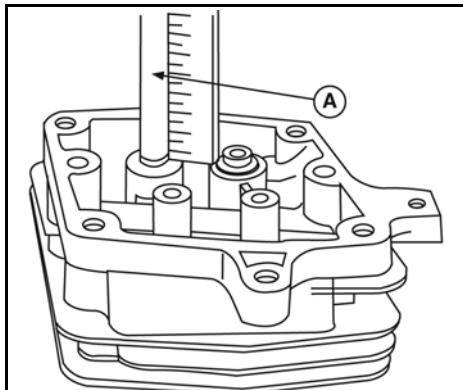


Figure 11

- If guides are replaced, or the original guides still meet specifications, use Finish Reamer #19066 and Reamer Guide #19191 to ensure proper sizing and to clean out the guides. Thoroughly clean all reaming debris from cylinder head.

- Inspect valves for wear or damage. Replace if necessary.

**NOTE:** Valve faces can be resurfaced on a commercially available valve grinder. However, Briggs & Stratton does not recommend this practice because the quality of the resurfacing may be insufficient. Instead, valve replacement is recommended.

- Oil the intake valve guide and intake valve stem, then insert valve into head.
- Using Valve Lapping Tool #19258 and Lapping Compound #94150, lap valve and seat together to assure a good sealing surface. Remove valve, the repeat procedure for the exhaust valve.
- Thoroughly clean both valves and cylinder head of all lapping compound residue.

#### Assemble Cylinder Head

- Install new plastic push rod guides into the cylinder head plate (A, Figure 12) (models 110000, 120000, 150000). Using new plate gasket, install the cylinder head plate. Torque screws to values listed in Section 12 - Engine Specifications.

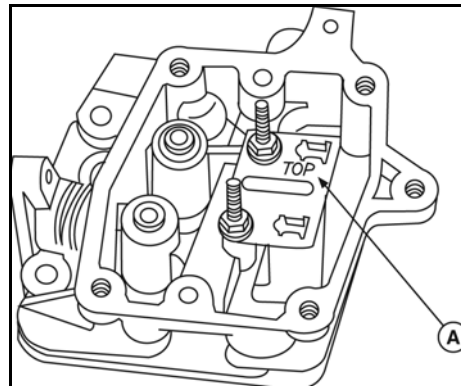


Figure 12

- Lightly coat valve stems with Valve Guide Lubricant #93963, then insert valves into cylinder head. Do not get lubricant on valve face, valve seat, or exposed end of valve stem.
- Oil inside diameter of new stem seal/washer and install on intake valve stem. Slide seal down against head plate or cylinder head (A, Figure 13).

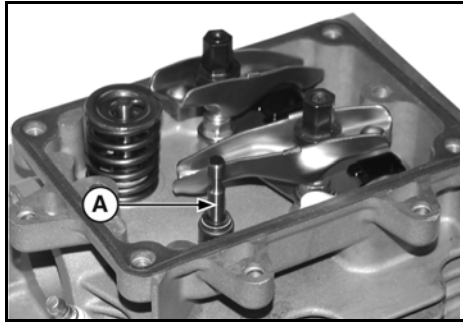


Figure 13

4. Support valve side of cylinder head on clean shop rags. Place valve springs and valve spring retainers over valve stems. Using thumbs, press against each retainer until it securely locks into groove in valve stem (Figure 14).

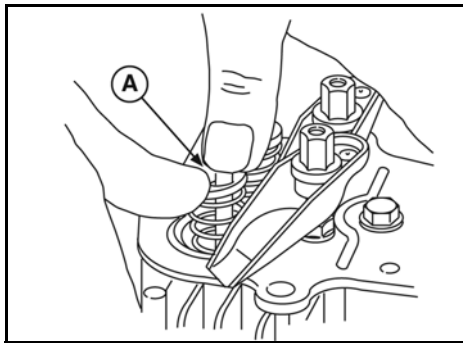


Figure 14

**Install Cylinder Head**

1. Coat threads of all cylinder head screws with Valve Guide Lubricant #93963.
2. Using a new head gasket, install cylinder head on cylinder and start screws by hand. Step-torque screws in sequence shown (Figures 15, 16, 17, 18) until final torque value is achieved. Torque screws to value listed in Section 12 - Engine Specifications.

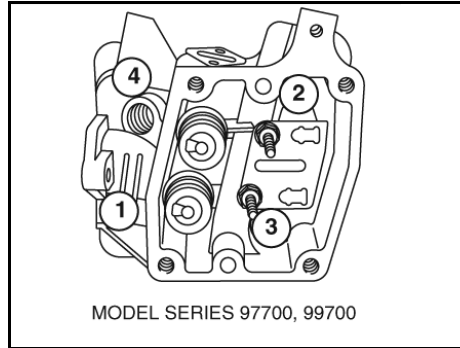


Figure 15

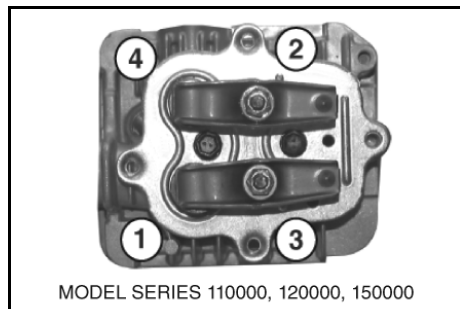


Figure 16

6

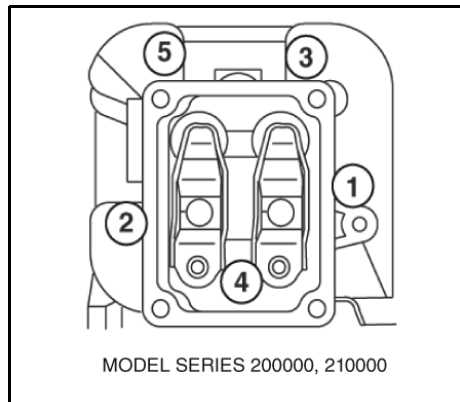


Figure 17

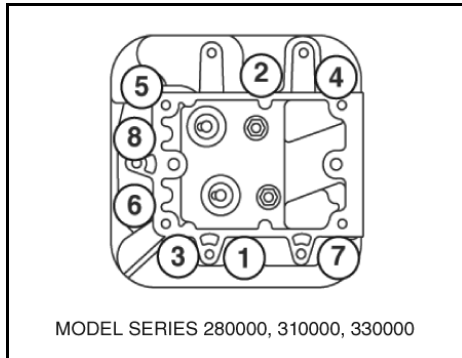


Figure 18

**NOTE:** Do not torque each screw in one step as it may result in a warped cylinder head. Step-torque all screws to approximately 1/3 of final torque value, then to 2/3 final torque value, then finish at final torque value.

3. Install push rod guide and rocker arm studs (models 97700, 99700). Torque studs to values listed in Section 12 - Engine Specifications.

**-OR-**

4. Install rocker arm studs (models 110000, 120000, 150000). Torque to values listed in Section 12 - Engine Specifications.

**NOTE:** Early production of vertical models 110000 and 120000 require a jam nut to be threaded approximately half way up the threads of the stud before installation into the head.

5. Install push rods through guides and into same positions as removed. Ensure rods are seated in valve tappets. Place valve stem caps (if used) on valve stems.
6. Place rocker arms and rocker balls on rocker arm studs (Figure 19). Install rocker arm screws and/or lock nuts on studs and tighten until there is zero clearance between the valve stem caps and the rocker arms.

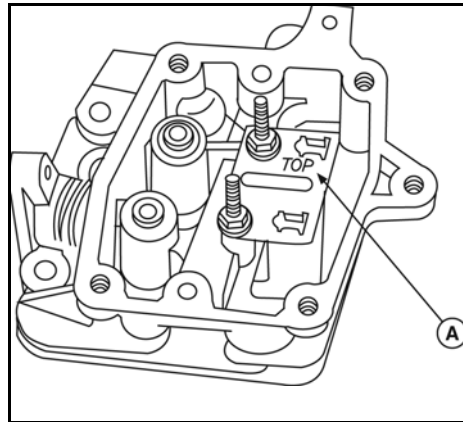


Figure 19

7. Rotate crankshaft at least twice to ensure proper movement of the push rods and rocker arms.
8. Adjust valve clearance per Section 1, then install a new rocker cover gasket and the rocker cover. Torque screws to values listed in Section 12 - Engine Specifications.

## Remove Cylinder Head

### Models 200000, 210000, 280000, 310000, 330000

1. Remove four screws from rocker cover, then remove cover and gasket (A, Figure 20).

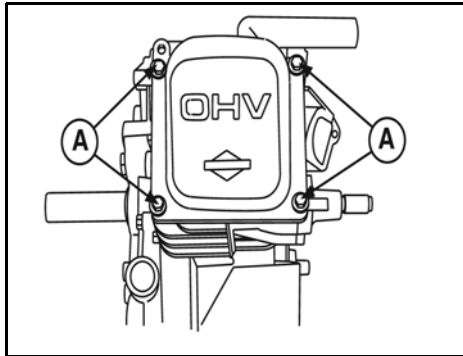


Figure 20

2. Remove cylinder head screws, then remove head and gasket from cylinder.
3. Remove push rods one at a time, marking the location and orientation of each for proper installation later.

**NOTE:** On models 210000, 280000, 310000, 330000 the intake push rod (lower, aluminum) is hollow and the exhaust push rod (upper, steel) has a red band of paint for identification.

4. Using a plastic scraping tool, carefully clean all traces of head gasket from the head and cylinder mating surfaces.

### Disassemble Cylinder Head

1. Loosen rocker arm screws and/or lock nuts, and remove from rocker arm studs (A, Figure 21).

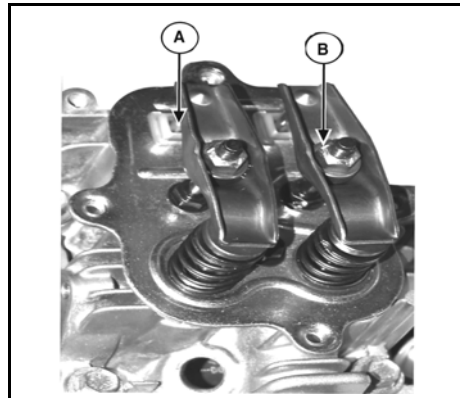


Figure 21

2. Remove the rocker arm studs.
3. Using thumbs, press down on each valve spring retainer and disengage retainer (A, Figure 22) from valve stem (B). Remove retainers, springs, valves, and intake valve stem seal/washer, if equipped.

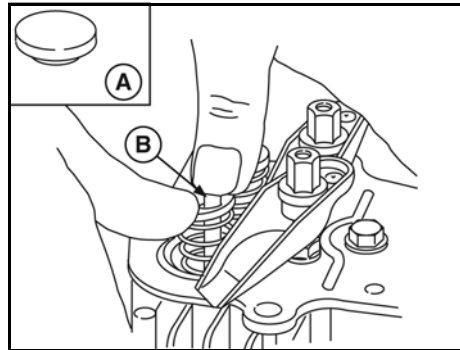


Figure 22

4. Remove push rod cylinder head plate and plate gasket. Remove and discard the plastic push rod guides from the head plate.

### Inspection

1. Visually inspect head for cracks, excessive heat discoloration, warping of the cylinder or rocker cover mating surfaces, and burned or damaged valve seats. Replace head, if any of these problems are found.
2. If head passes visual inspection, use Plug Gauge #19122 to check valve guides for wear. If gauge enters the guide 1/4" (6.4

mm) or more, replace the entire head. If plug gauge is not available, see Section 12 - Engine Specifications for the valve guide reject dimension.

3. If guides are replaced, or the original guides still meet specifications, use Finish Reamer #19066 and Reamer Guide #19191 to ensure proper sizing and to clean out the guides. Thoroughly clean all reaming debris from cylinder head.
4. Inspect valves for wear or damage. Replace if necessary.

**NOTE:** Valve faces can be resurfaced on a commercially available valve grinder. However, Briggs & Stratton does not recommend this practice because the quality of the resurfacing may be insufficient. Instead, valve replacement is recommended.

5. Oil the intake valve guide and intake valve stem, then insert valve into head.
6. Using Valve Lapping Tool #19258 and Lapping Compound #94150, lap valve and seat together to assure a good sealing surface. Remove valve, then repeat procedure for the exhaust valve.
7. Thoroughly clean both valves and cylinder head of all lapping compound residue.

3. Lightly coat valve stems with Valve Guide Lubricant #93963. then insert valves into cylinder head. Do not get lubricant on valve face, valve seat, or exposed end of valve stem.
4. Oil inside diameter of new stem seal/washer and install on intake valve stem. Slide seal down against head plate or cylinder head.
5. Support valve side of cylinder head on clean shop rags. Place valve springs and valve spring retainers over valve stems. Using thumbs, press against each retainer until it securely locks into groove in valve stem (A, Figure 24).

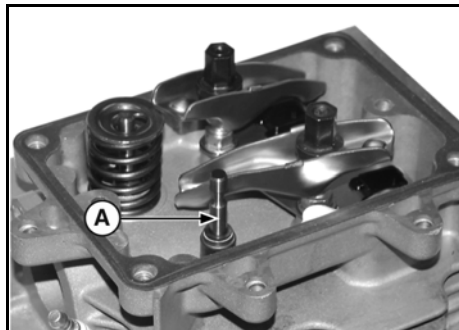


Figure 24

6

#### Assemble Cylinder Head

1. Install new plastic push rod guides (A, Figure 23) into the cylinder head plate.

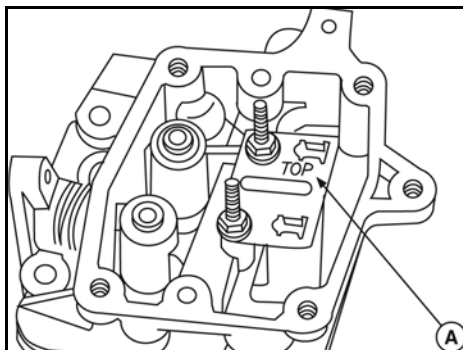


Figure 23

2. Using new plate gasket, install the cylinder head plate. Torque screws to values listed in Section 12 - Engine Specifications.

#### Install Cylinder Head

1. Coat threads of all cylinder head screws with Valve Guide Lubricant #93963.
2. Using a new head gasket, install cylinder head on cylinder and start screws by hand. Step-torque screws in sequence shown in Figures 25, 26, 27, and 28 until final torque value is achieved. Torque screws to value listed in Section 12 - Engine Specifications.

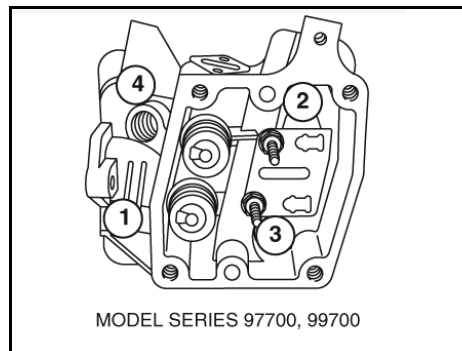


Figure 25

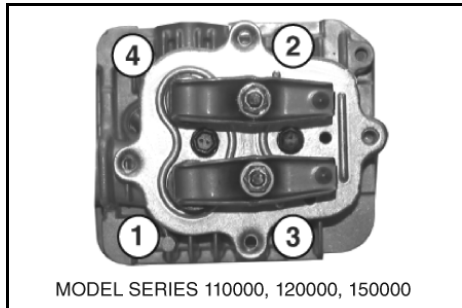


Figure 26

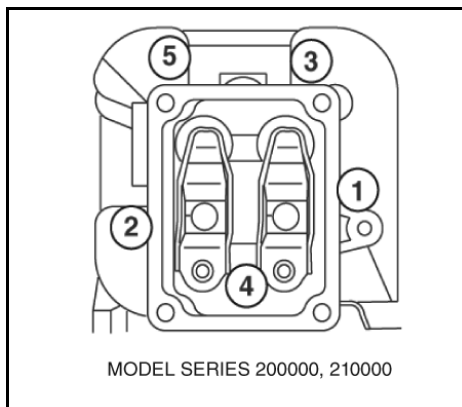


Figure 27

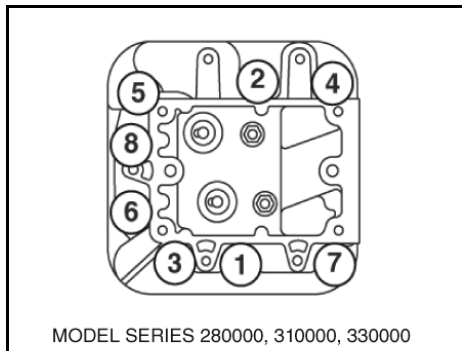


Figure 28

**NOTE:** Do not torque each screw in one step as it may result in a warped cylinder head. Step-torque all screws to approximately 1/3 of final torque value, then to 2/3 final torque value, then finish at final torque values.

3. Install rocker arm studs. Torque to values listed in Section 12 - Engine Specifications.

4. Install push rods through guides and into same positions as removed. Ensure rods are seated in valve tappets. Place valve stem caps (if used) on valve stems (Figure 29).

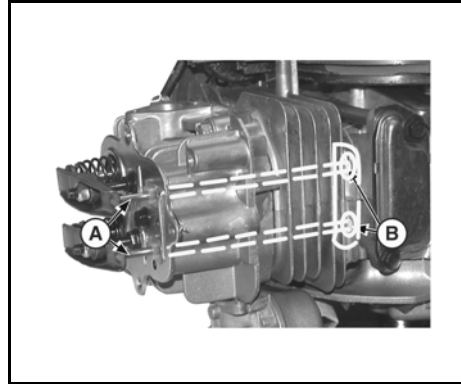


Figure 29

5. Place rocker arms and rocker balls on rocker arm studs. Install rocker arm screws and/or lock nuts on studs and tighten until there is zero clearance between the valve stem caps and the rocker arms.
6. Rotate crankshaft at least twice to ensure proper movement of the push rods and rocker arms.
7. Adjust valve clearance per Section 1, then install a new rocker cover gasket and the rocker cover. Torque screws to values listed in Section 12 - Engine Specifications.

6



6

## SECTION 7 - STARTERS

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## REWIND STARTERS

On some engines, the rewind starters are attached to the blower housing with screws and can be quickly removed.

Other starters are riveted or spot welded to the blower housing and must be drilled to remove, following the procedures below. For installation, screws and nuts are available separately from the Illustrated Parts List and are included with complete replacement starters.

### Remove Blower Housing / Rewind Starter

#### Horizontal Models 110000, 120000, 150000, 200000, 210000

1. Drain fuel tank or close fuel shut-off valve. Disconnect spark plug wire.
2. Remove the entire air cleaner assembly.
3. Remove the screws (A, Figure 1) and the control panel trim.



Figure 1

4. Remove the screws (B, Figure 2) and blower housing.

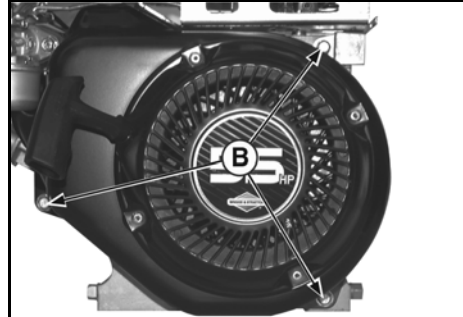


Figure 2

5. Carefully drill through all rivet heads and remove rewind starter. Do not allow drill bit to cut into the holes in the starter housing.

**NOTE:** Do not attempt to drill out the rivets while the blower is still on the engine. The rivets are made of steel and the shavings will collect on the flywheel magnets.

#### Vertical Models 97700, 99700

1. Drain fuel tank or close fuel shut-off valve. Disconnect fuel hose from carburetor and drain residual fuel. Disconnect spark plug wire.
2. Remove the screws and the finger guard (A, Figure 3) and the fuel tank (B).

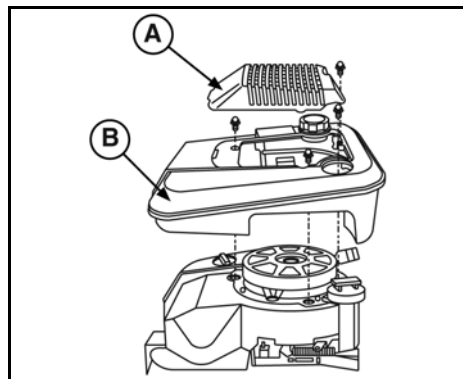


Figure 3

3. Remove the oil fill tube and dipstick (C, Figure 4).
4. Remove the screws and blower housing (D).

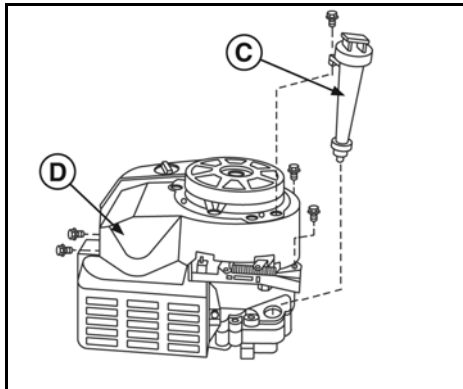


Figure 4

5. Carefully drill through all rivet heads and remove rewind starter. Do not allow drill bit to cut into the holes in the starter housing.

**NOTE:** Do not attempt to drill out the rivets while the blower is still on the engine. The rivets are made of steel and the shavings will collect on the flywheel magnets.

#### Vertical Models 110000, 120000

1. Drain fuel tank or close fuel shut-off valve, disconnect fuel hose from carburetor and drain residual fuel. Disconnect spark plug wire.
2. Remove air cleaner cover. Using flat bladed screwdriver, press on tab (A, Figure 5) and lift finger guard off engine.



Figure 5

3. Remove screws (B, Figure 6) from trim plate or (C) from rewind guard. Remove trim plate or guard.

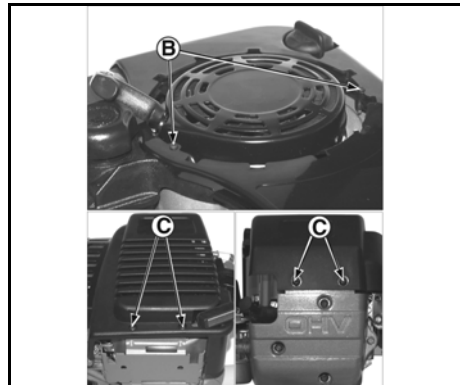


Figure 6

4. Remove screws (D, Figure 7) and screw and spacer (E), then remove tank from engine.

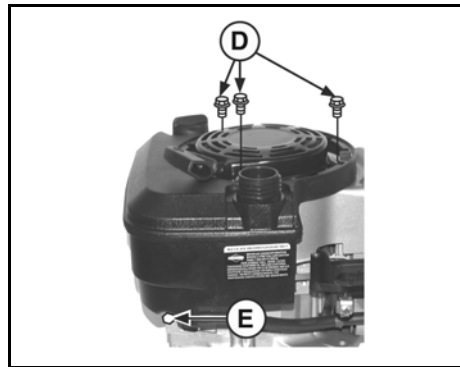


Figure 7

**NOTE:** On some model 120000 engines, the fuel tank is mounted to a tank bracket. Loosen the screws at the bottom of the bracket and the side of the cylinder, then slide the tank up and off the bracket.

5. Remove the oil fill tube and dipstick. Remove the screws (F, Figure 8) and blower housing.

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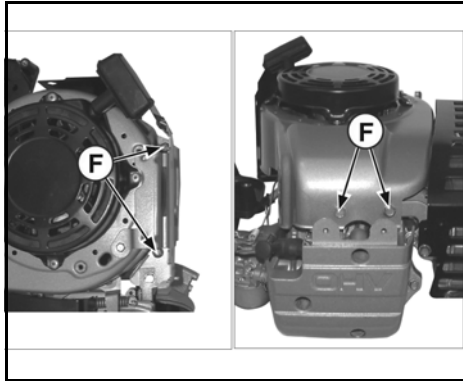


Figure 8

6. Carefully drill through all rivet heads and remove rewind starter. Do not allow drill bit to cut into the holes in the starter housing.

**NOTE:** Do not attempt to drill out the rivets while the blower is still on the engine. The rivets are made of steel and the shavings will collect on the flywheel magnets.

### Vertical Model 280000

1. Drain fuel tank or close shut-off valve. Disconnect spark plug wire.
2. Remove screws and separate fuel pump assembly from blower housing, if equipped.
3. Remove screws and blower housing (Figure 9).
4. If rewind starter is spot welded, use a 3/16" (4.8 mm) drill bit to drill through spot welds. Drill just far enough to loosen the welds, then remove rewind starter.

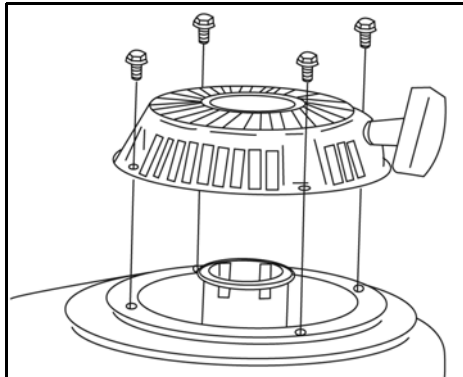


Figure 9

5. If rewind starter is riveted, carefully drill through all rivet heads and remove rewind starter. Do not allow drill bit to cut into holes in the starter housing.

**NOTE:** Do not attempt to drill out the rivets while the blower is still on the engine. The rivets are made of steel and the shavings will collect on the flywheel magnets.

### Service Rewind Starter

	<b>WARNING</b>
	<b>The starter spring remains under tension even if the rope has been removed and the pulley has unwound</b>
Wear safety glasses to prevent eye injury when removing or installing the pulley/spring assembly.	

### Disassemble Rewind Starter

1. Pull out rope from rewind starter as far as it will go. Then allow rope to retract slightly until the hole in the pulley and the eyelet in the housing are lined up. Securely clamp the pulley and housing together to prevent the pulley from spinning.
2. Pull the rope knot out of the pulley. Untie the knot and then slip rope out of rewind starter. Remove insert from rope handle. Untie knot and slip insert and handle from rope.
3. Carefully release the clamp on the starter and allow the pulley to SLOWLY unwind until it stops.
4. Remove shoulder screw and retainer plate from pulley. Lift out the pawls and pawl springs (if used).
5. Rotate pulley until rewind spring is disengaged from anchor tab in the starter housing. Carefully lift out pulley with spring. **DO NOT** remove the spring from the pulley.

### Inspect Rewind Starter Parts

**NOTE:** Do not remove the spring from the pulley. Both parts are serviced only as an assembly.

1. Inspect the pulley for wear, cracks, rough edges, or burrs in the rope groove and look for wear in the center hole. If wear or damage is found, replace the pulley and spring assembly.
2. Inspect the spring for broken ends, kinks, or burrs. If damage is found, replace the pulley and spring assembly.
3. Inspect the starter housing for wear or burrs at the rope eyelet, the center pivot post, and the anchor tab. If damage is found, replace the housing.
4. Inspect the drive pawls for wear at the tips or pivot points. Replace pawls if worn.
5. Inspect the rope for broken or frayed areas. Replace rope if necessary.

### Assemble Rewind Starter

1. Install pulley and spring assembly into starter housing. Rotate pulley clockwise until slight resistance is felt, which indicates that the spring has engaged in the anchor tab.
2. Install pawl springs (if used) and pawls. Position retainer plate on pulley. Ensure that the slots in the retainer fit over the tabs in the pulley, then install shoulder screw. Torque screw to value shown in Section 12 - Engine Specifications.
3. While holding retainer, rotate the pulley to extend and retract the pawls. If they do not move properly, remove and reinstall the retainer plate.
4. Turn pulley clockwise until the spring is wound tight. Then allow pulley to unwind slightly until the hole in the pulley and the eyelet in the housing are lined up. Securely clamp the pulley and housing together to prevent the pulley from spinning.

**NOTE:** Before proceeding, consult the Illustrated Parts List or Section 12 - Engine Specifications to ensure correct diameter and length of rope is being installed.

5. Insert one end of starter rope through eyelet and then through hole in pulley. Tie

an overhand knot in end of rope, then pull rope until knot is seated in pulley. Trim excess rope if necessary.

6. Slip other end of rope through handle and insert. Tie a knot in end of rope, then pull rope until knot is seated in the insert. Trim excess rope if necessary.
7. Quickly burn each end of the rope with an open flame to prevent swelling and fraying of the weave. Then press the handle insert into the rope handle.
8. Carefully release the clamp on the starter and allow the pulley to SLOWLY unwind until the rope is retracted. Smoothly pull the rope handle several times to ensure proper operation of the starter assembly.

### Install Blower Housing / Rewind Starter Horizontal Models 110000, 120000, 150000, 200000, 210000

Some starters are riveted or spot welded to the blower housing and must be drilled to remove. For installation, screws and nuts are available separately from the Illustrated Parts List and are included with complete replacement starters.

1. Install the blower housing and torque the screws to values listed in Section 12 - Engine Specifications.
2. Install the screws (A, Figure 10) and the control panel trim torquing the screws to values listed in Section 12 - Engine Specifications.
3. Install the air cleaner assembly.
4. Fill fuel tank or open fuel shut-off valve. Connect the spark plug wire.



Figure 10

### Vertical Models 97700, 99700

1. Install the screws to the blower housing (D, Figure 11), torquing screws to values listed in Section 12 - Engine Specifications.
2. Install the oil fill tube and dipstick (C).

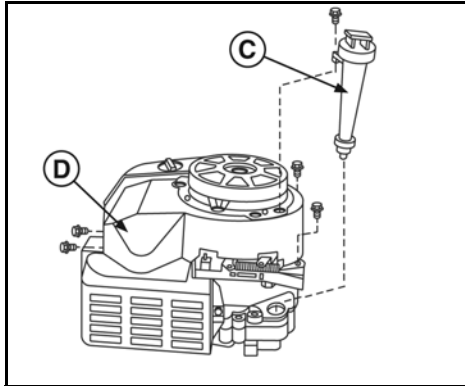


Figure 11

3. Install the screws to the finger guard (A, Figure 12) and the fuel tank (B), torquing screws to values listed in Section 12 - Engine Specifications.
4. Fill fuel tank or open fuel shut-off valve. Connect fuel hose to carburetor. Connect spark plug wire.

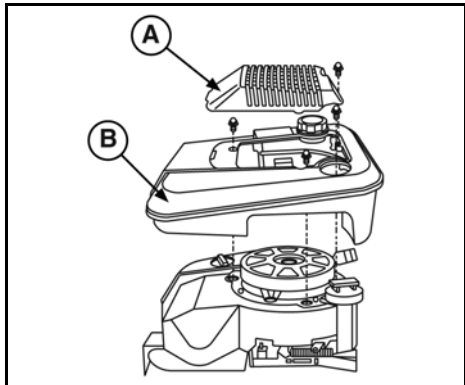


Figure 12

### Vertical Models 110000, 120000

1. Install the oil fill tube and dipstick. Install the screws (F, Figure 13) and blower housing.

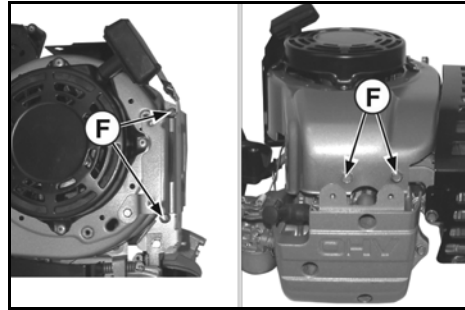


Figure 13

2. Install screws (D, Figure 14) and spacer (E), then install tank from engine. Torque screws to values listed in Section 12 - Engine Specifications.

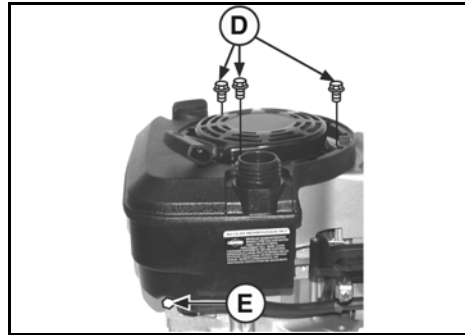


Figure 14

3. Install screws (B, Figure 15) to trim plate or (C) to rewind guard. Torque screws to values listed in Section 12 - Engine Specifications.

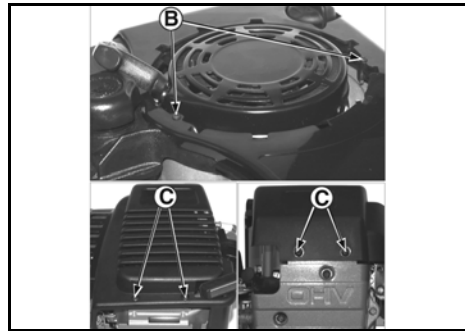


Figure 15

4. Install air cleaner cover. Press on tab (A, Figure 16) until finger guard attaches to engine.

5. Fill fuel tank or open fuel shut-off valve. Connect fuel hose to carburetor and connect spark plug wire.

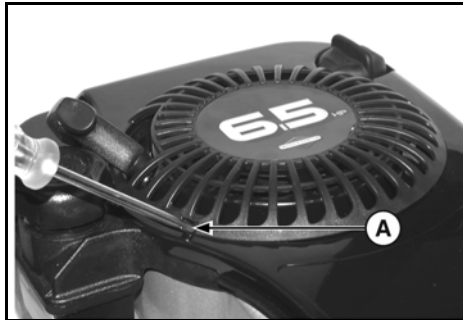


Figure 16

### Vertical Model 280000

1. For installation, screws and nuts are available separately from the Illustrated Parts List and are included with complete replacement starters.
2. Attach blower housing with screws (Figure 8) and torque to values listed in Section 12 - Engine Specifications.
3. Attach fuel pump assembly to blower housing, if equipped.
4. Fill fuel tank, open shut-off valve, and connect spark plug wire.

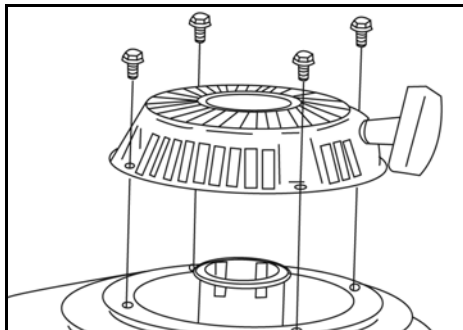


Figure 17

### Service Starter Clutch

Some Vertical model 280000s utilized a sealed starter clutch on the rewind starters. The starter clutch assembly consists of a seal (A, Figure 18), ratchet (B), clutch housing (C), retainer cover (D), and 6 ball bearings (E).

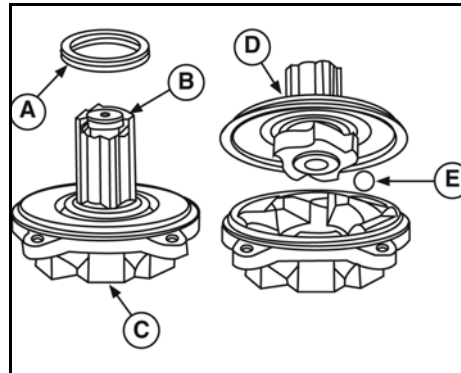


Figure 18

### Disassemble Starter Clutch

1. Using Starter Clutch Wrench #19244 and Flywheel Strap Wrench #19433, remove clutch from crankshaft.
2. Remove retaining screws (if used) from clutch housing. Using a screwdriver or wedge, pry the cover from the housing.

**NOTE:** Perform this procedure over a small bowl to catch the clutch balls as the cover comes off.

### Inspect Clutch Parts

1. Using Carb/Choke Cleaner #100041 or #100042, clean the inside of the cover, housing, and clutch balls. Clean the ratchet by wiping with a cloth (do not use spray).
2. Inspect cleaned surfaces for evidence of wear or damage. Replace entire clutch assembly if found.
3. Stand ratchet upright on work surface and add one or two drops of clean oil to the lubrication hole in the Welch plug (B, Figure 18). Allow several minutes for the oil to be absorbed by the felt disc inside the ratchet.

### Assemble Starter Clutch

1. Drop one clutch ball into each pocket in the clutch housing.

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2. Wipe off any excess oil from the top of the ratchet, then place the ratchet on the housing.
3. Install the retainer cover and seal over the ratchet and press into housing until fully closed. Install retaining screws (if used).
4. Place one drop of clean engine oil on top of crankshaft pilot, then install clutch on crankshaft. Using the Starter Clutch Wrench and Flywheel Strap Wrench, tighten the clutch to the value listed in Section 12 - Engine Specifications.

## ELECTRIC STARTERS

### Replace Ring Gear

All Briggs & Stratton engines use an aluminum, plastic, or steel ring gear on the flywheel. Replace the ring gear if it shows wear or damage. Some steel ring gears are pressed or heat shrunk to the flywheel. These ring gears are not replaceable.

To replace a worn or damaged flywheel ring gear, proceed as follows:

1. Mark center of rivets holding ring gear (A, Figure 18) to flywheel, with a center punch.
2. Drill out rivets using a 3/16" (4.7 mm) drill bit.
3. Remove the ring gear and clean holes after drilling.
4. Attach new gear to flywheel using four screws (B) and lock nuts (C) provided with the gear.

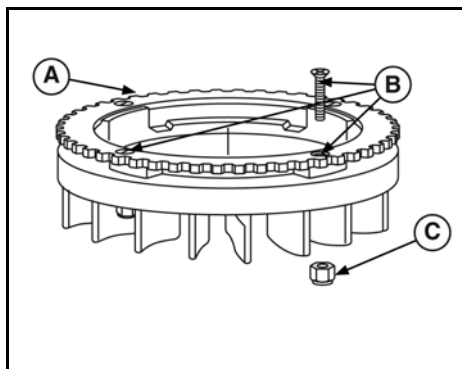


Figure 19

### System 3®, System 4®

#### Check Starter Drive and Clutch

When starter switch is activated, pinion gear (A, Figure 19) should engage the ring gear and crank engine. The clutch should not slip during engine cranking and pinion gear shouldn't bind on the helix (B).

**NOTE:** Do not oil the pinion gear or helix.

1. Remove the starter from the engine.
2. Using a mild solvent, clean the drive and clutch assembly, then dry with compressed air.
3. Inspect for damaged parts and replace if necessary.
4. Install starter on engine and test for proper operation.
5. Replace the entire starter drive assembly if the clutch slips or if the pinion gear binds on the helix.

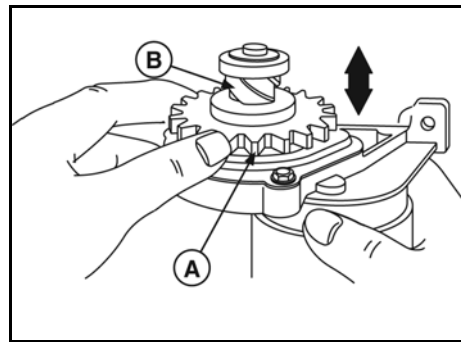


Figure 20

### Remove Starter Drive and Clutch

1. Remove E-ring (A, Figure 20).
2. Remove three screws (B) holding gear cover.
3. Lift clutch assembly and gears from shaft.

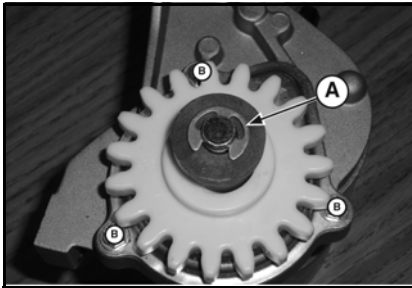


Figure 21

### Install Starter Drive and Clutch

1. Slip pinion (A, Figure 21) on motor shaft.
2. Add approximately 3/4 ounce of Briggs & Stratton Grease #100059 under drive gear end and on gear teeth.
3. Using new gasket, install clutch assembly to shaft and align pinion with drive gear.
4. Install three screws and torque to values listed in Section 12 - Engine Specifications.
5. Install E-ring.

**NOTICE:** Do not oil the pinion gear or helix.



Figure 22

## 12 Volt Starters

### Check Starter Drive and Clutch

When starter switch is activated, pinion gear should engage the ring gear and crank engine. The clutch should not slip during engine cranking and pinion gear shouldn't bind on the helix.

**NOTE:** Do not oil the pinion gear or helix.

1. Remove the starter from the engine.
2. Using a mild solvent, clean the drive and clutch assembly, then dry with compressed air.
3. Inspect for damaged parts and replace if necessary.
4. Install starter on engine and test for proper operation.
5. If the clutch slips or if the pinion gear binds on the helix, replace the entire starter drive assembly using the following procedures.

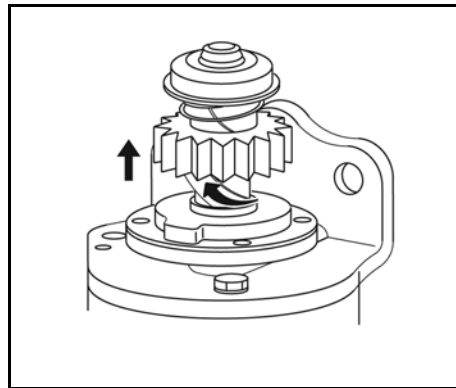


Figure 23

### Disassemble Starter Drive - C-Ring Retainer

1. Using C-Ring Removal Tool #19522, remove and discard old C-ring (Figure 23).

7

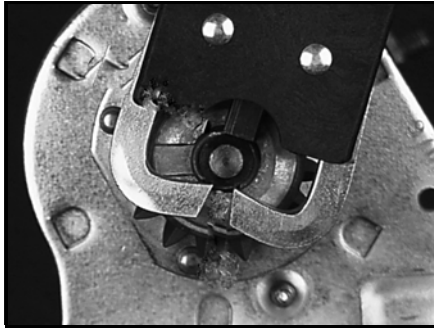


Figure 24

2. Remove retainer (A, Figure 24), return spring (B), flat washer (C), wave washer (D), pinion gear (E), and starter clutch (F).

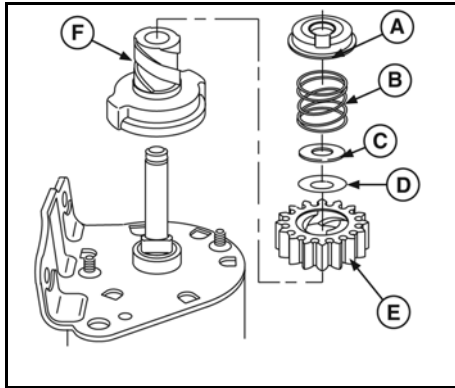


Figure 25

#### Assemble Starter Motor Drive - C-Ring Retainer

1. Place clutch on starter shaft (A, Figure 25). Rotate clutch until it drops into place (B).

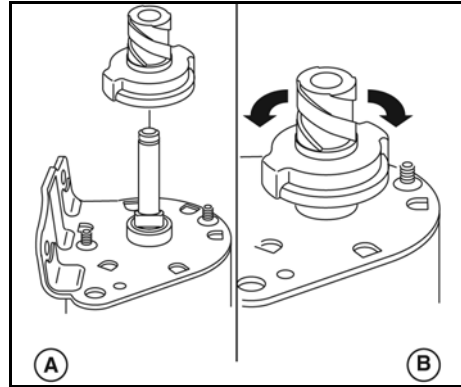


Figure 26

2. Install pinion gear (C, Figure 26) with beveled edge of teeth up. Install return spring (D) into recess of pinion gear.

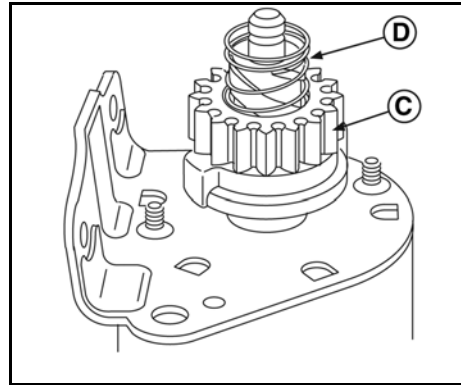


Figure 27

3. Place wave washer (E, Figure 27) with concave side up and flat washer (F) on starter clutch spline.

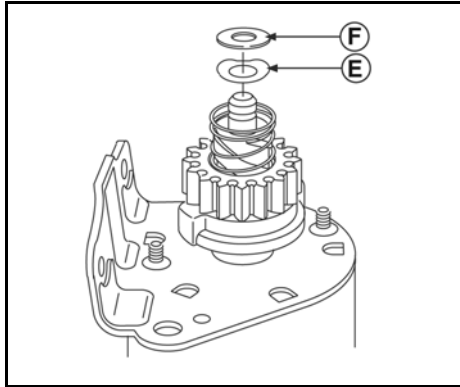


Figure 28

4. Place new C-ring over chamfered end of shaft.
5. Align one of the slots (G, Figure 28) of C-Ring Installer #19435 with open end of C-ring (H).
6. Press on tool until C-ring snaps into groove in shaft.
7. Manually actuate pinion gear on helix to ensure proper movement.

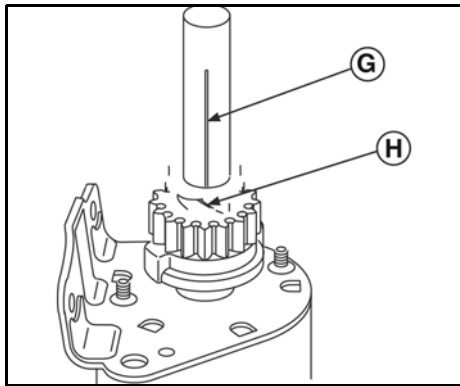


Figure 29

**Disassemble Starter Drive - Roll Pin Retainer**

1. Place starter drive retainer on support block (Figure 29) and drive out roll pin (A, Figure 30) with a 5/32" (.4mm) pin punch. Discard roll pin.

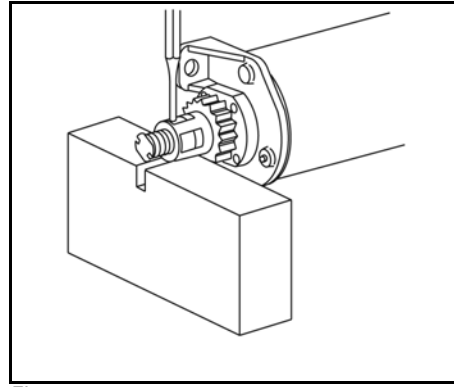


Figure 30

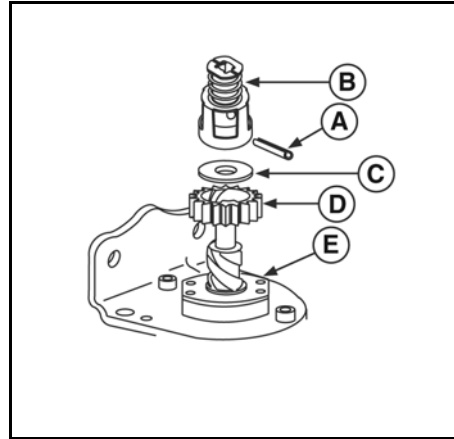


Figure 31

2. Remove retainer (B), washer (C), pinion gear (D), and starter clutch (E) from starter shaft.

7

### Assemble Starter Drive - Roll Pin Retainer

1. Place clutch (E, Figure 31) on starter shaft and rotate clutch until it drops into place.

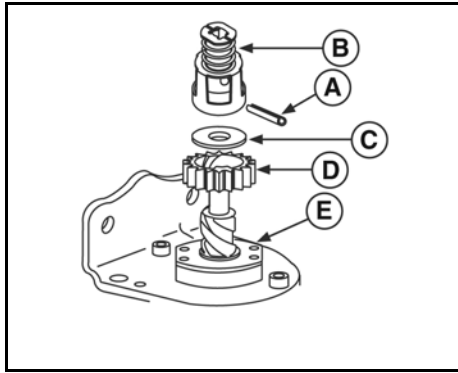


Figure 32

2. Install pinion gear (D) with beveled edge of teeth up.
3. Place washer (C) and retainer (B) on starter shaft.
4. Press new roll pin (A) through retainer slot and starter shaft hole until pin is centered in shaft.
5. Manually actuate pinion gear on helix to ensure proper movement.

7

### 120-Volt Starters

The 120-Volt AC starter motors are not serviceable. If a failure occurs, the entire motor/switch assembly must be replaced. Refer to the appropriate Illustrated Parts List to obtain replacement part numbers.

## SECTION 8 - LUBRICATION SYSTEMS

---

<b>EXTENDED OIL FILL AND DIPSTICK</b>	<b>-116</b>
<b>BREATHERS</b>	<b>-116</b>
HORIZONTAL MODELS 110000, 120000, 150000, 200000, 210000	-116
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VERTICAL MODELS 280000, 310000	-117
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## EXTENDED OIL FILL AND DIPSTICK

### Horizontal Models 110000, 120000, 150000, 200000, 210000

These models use a plastic extended oil fill tube and a quarter-turn dipstick. The oil fill tube screws into the crankcase cover.

### Vertical Models 90000, 110000, 120000, 210000, 280000, 310000, 330000

These models use a plastic extended oil fill tube and a quarter-turn, dipstick. An o-ring seals the tube in the crankcase cover and a retaining bracket and screw secure it to the engine.

## BREATHERS

Briggs & Stratton engines utilize a breather valve to control and maintain crankcase vacuum. The breather valve is a fiber disc or reed which closes on the piston up stroke and opens on the piston down stroke.

The breather is located on the cylinder or inside the rocker cover, depending on engine model.

### Service Breather - Horizontal Models 110000, 120000, 150000, 200000, 210000

#### Remove Breather

1. Disconnect breather hose (B, Figure 1) from air cleaner.
2. Remove rocker cover with breather hose (A) and gasket. Discard gasket.

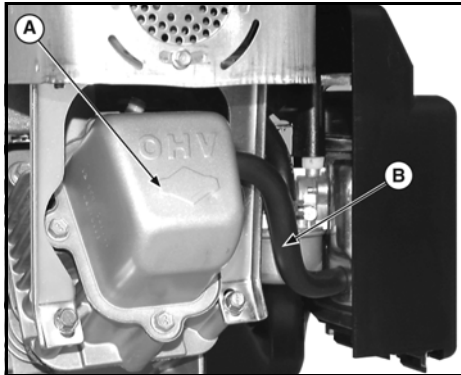


Figure 1

#### Check Breather

1. Gently blow air into the breather tube. There should be no air flow out the valve.

2. Apply vacuum to the breather tube. Air should flow freely into the valve.
3. If air flow is restricted under vacuum at the tube, or has no resistance when blowing on the tube, replace the valve cover.

#### Install Breather

1. Securely insert breather hose into hole in air cleaner base.
2. Place new gasket and valve cover on cylinder head.
3. Install four screws and torque to values listed in Section 12 - Engine Specifications.

**NOTE:** Install three long screws on the sides and bottom edges of valve cover. Install short screw on top of valve cover.

4. Securely insert other end of breather hose into hole in rocker cover.

### Service Breather - Vertical Models 97700, 99700, 110000, 120000

#### Remove Breather

1. Remove two screws, breather assembly (A, Figure 2) and gasket (B) from side of cylinder. Discard gasket.
2. Remove four screws, breather passage cover (C), and gasket (D) from top of cylinder. Discard gasket.

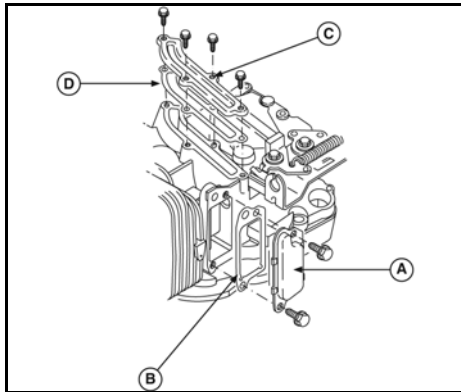


Figure 2

#### Check Breather

1. Check for movement of the disc valve in the breather assembly. If disc is stuck or binding, replace the breather assembly.
2. Visually inspect the assembly for warping, wear, or damage. If these conditions are found, replace the breather assembly.
3. Inspect oil drain-back holes (C, Figure 3) to make sure they are open. Clean as needed.
4. Using 0.045" (1.14 mm) wire gauge, check clearance between the disc valve (B) and the housing (A). If gauge can be inserted, replace the breather assembly.

**NOTE:** Do not apply force to the wire gauge! The disc valve is retained by an internal bracket which will be distorted if pressure is applied to disc.

5. Inspect breather passage on top of cylinder for debris and/or blockage. Carefully clean this area if necessary, ensuring passage holes are open.

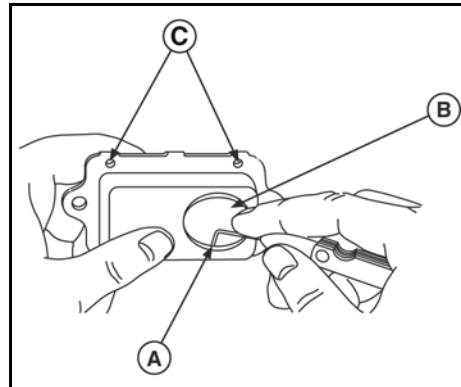


Figure 3

#### Install Breather

1. Install new breather passage gasket and breather passage cover on top of cylinder. Torque four screws to values listed in Section 12 - Engine Specification.
2. Place new breather gasket and breather assembly on side of cylinder. Torque two screws to values listed in Section 12 - Engine Specification.

#### Service Breather - Vertical Models 280000, 310000 Early Production

##### Remove Breather

1. Remove breather tube from breather assembly on side of cylinder.
2. Remove two screws, breather assembly, and gasket. Discard gasket.

##### Check Breather

1. Check for movement of the disc valve in the breather assembly. If disc is stuck or binding, replace the breather assembly.
2. Visually inspect the assembly for warping, wear, or damage. If these conditions are found, replace the breather assembly.
3. Inspect oil drain-back holes (C, Figure 4) to make sure they are open. Clean as needed.
4. Using 0.045" (1.14 mm) wire gauge, check clearance between the disc valve (B) and the housing (A). If gauge can be inserted, replace the breather assembly.



**NOTE:** Do not apply force to the wire gauge! The disc valve is retained by an internal bracket which will be distorted if pressure is applied to disc.

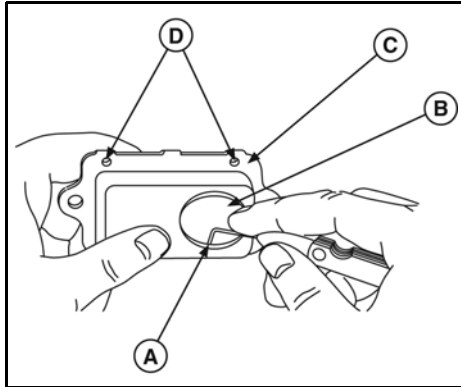


Figure 4

#### Install Breather

1. Place new gasket and breather assembly on cylinder. Torque to screws to values listed in Section 12 - Engine Specifications.
2. Securely insert breather tube into breather assembly.

### Service Breather - Vertical Models 210000, 280000, 310000, 330000 Current Production

#### Remove Breather

1. Remove breather tube (B, Figure 5) from breather cover (A).

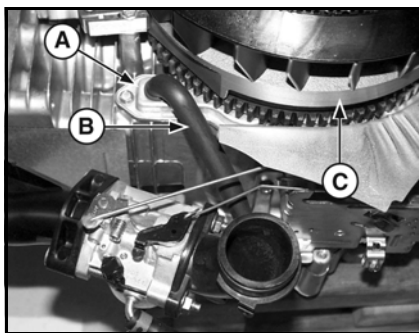


Figure 5

2. Remove two screws (B, Figure 6), breather cover. Discard gasket (before

date code 070719xx) or clean off sealant (after date code 070718xx).

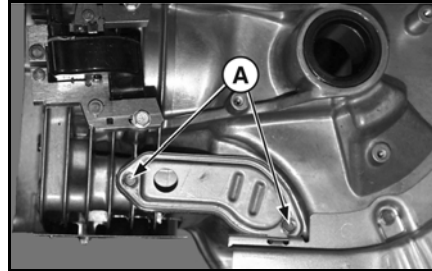


Figure 6

#### Check Breather

1. Remove and check breather reed (A, Figure 7). If the reed is worn or bent, it cannot function properly and must be replaced.

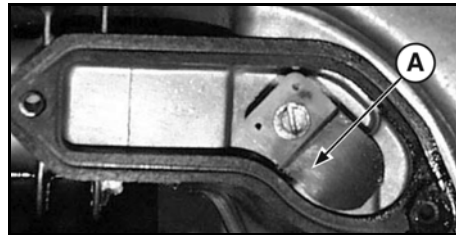


Figure 7

2. Inspect the oil drain-back hole (B, Figure 8). Insert a fine wire to ensure the opening is not plugged.

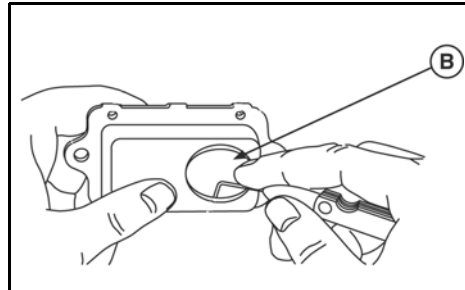


Figure 8

### Install Breather

1. Install reed with the metal tab facing outside of the engine, as shown in Figure 8. Torque screw to values listed in Section 12 - Engine Specifications.
2. Place new gasket or sealant on cylinder. Install breather cover and torque screws to

values listed in Section 12 - Engine Specifications.

3. Securely install breather tube in breather cover.

## LUBRICATION SYSTEMS

Four types of lubrication systems are available:

1. Oil Dipper on connecting rod.
2. Oil Slinger on governor gear.
3. Oil Slinger with pressure filtration.
4. Pressure Lubrication.

### Oil Dipper Lubrication

**Horizontal Models 110000, 120000, 150000, 200000, 210000**

Two types of dippers are used on horizontal shaft engines. One is integral to the rod cap, the other is a separate part (A, Figure 9) attached to the rod cap with a connecting rod screw.

Inspect the dipper for evidence of bending, cracking, or looseness. Replace if necessary following instructions in Section 11 - Pistons, Rings, and Connecting Rods.

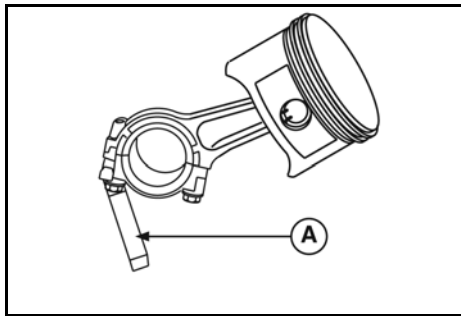


Figure 9

### Oil Slinger Lubrication

**Vertical Models 97700, 99700, 110000, 120000, 210000, 280000, 310000, 330000**

The oil slinger/governor gear (A, Figure 10) is used on vertical shaft engines. It is mounted to and driven by the cam gear.

Visually inspect oil slinger/governor gear assembly for wear, broken teeth, broken slinger paddles, or burrs. Replace assembly if worn or damaged.

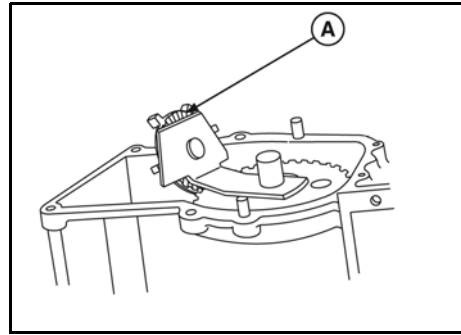


Figure 10

8

### Oil Slinger with Pressure Filtration

#### Vertical Models 120000, 210000, 280000, 310000, 330000

Some of these models are equipped with a gerotor pump that draws oil from the sump, pumps it through the oil filter, and back to the sump (Figure 11). The gerotor pump is driven by the cam gear. The slinger splashes oil throughout the crankcase.

**NOTE:** This system does **not** supply oil under pressure to any of the bearing surfaces.

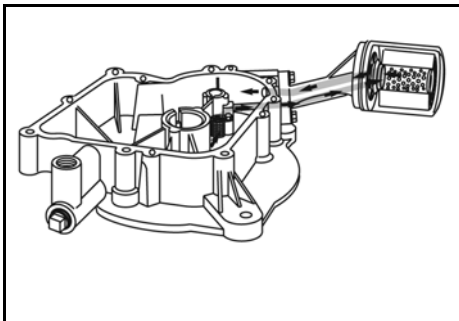


Figure 11

### Pressure Lubrication

#### Vertical Models 97700, 99700

A gerotor pump supplies oil to the camshaft bearings and the magneto bearing. The gerotor is located in the bottom of the sump, and is driven by camgear. Oil enters the pump through a slot and is pushed up the hollow camshaft to the magneto upper camshaft bearing and through a drilled passage to the crankshaft magneto bearing (Figure 12). The oil slinger lubricates the remaining bearings and journals.

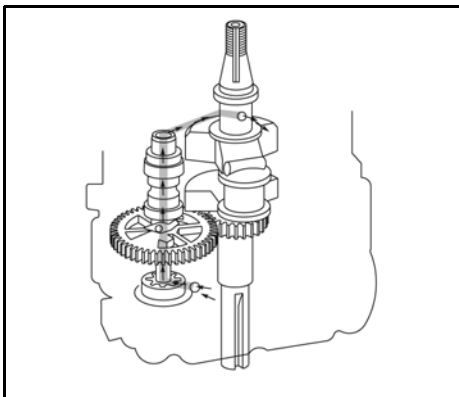


Figure 12

#### Vertical Models 280000, 310000, 330000

On some of these models the gerotor pump draws oil from the sump and pumps it through the oil filter, then directly to the PTO bearing in the sump (Figure 14).

The gerotor pump is driven by the cam gear. An optional oil pressure gauge or switch can be installed at the oil filter adapter.

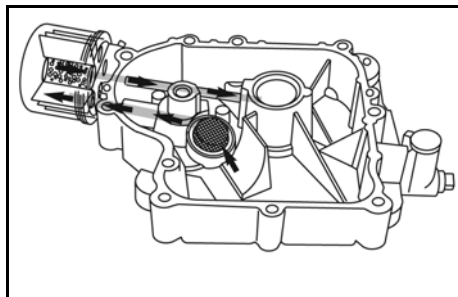


Figure 13

### Oil Pump Service

The oil pump can be removed from the outside of the sump (A, Figure 14). The oil pump screen, however, must be removed from the inside of the sump.

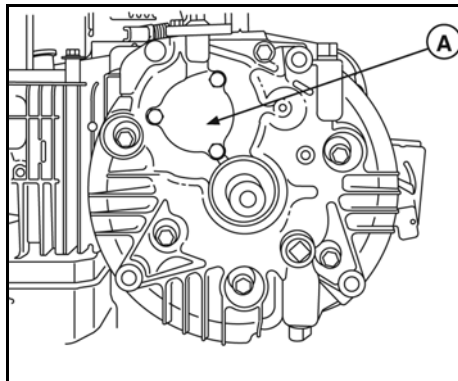


Figure 14

#### Remove Gerotor Pump

1. Remove three screws then remove pump cover (A, Figure 15) and o-ring (B).

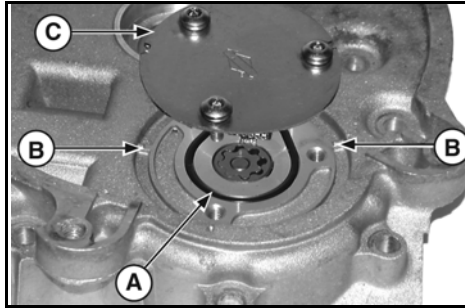


Figure 15

2. Carefully remove inner (C) and outer rotors (D).

**NOTICE:** Depending on Model Series, inner rotor may include the drive shaft or the drive shaft may be a separate part. Remove shaft, when it is a separate part.

**Remove Pump Screen**

Three types of oil pump screens have been used on models 280000, 310000, 330000.

Early oil pump screens (A, Figure 16) (before date code 94110700) were mounted inside the sump and held with one screw (B).

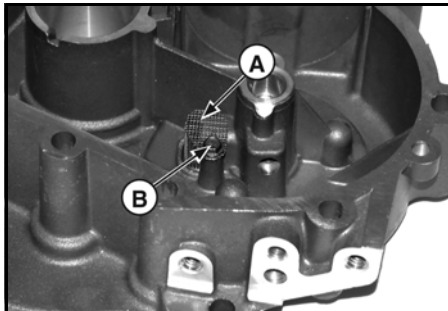


Figure 16

The intermediate screen (A, Figure 17) (after date code 94110600) can be removed at the same time as the oil pump.

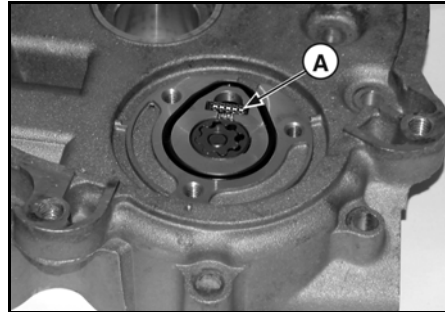


Figure 17

Current oil pump screen must be driven out from inside the sump (Figure 18).

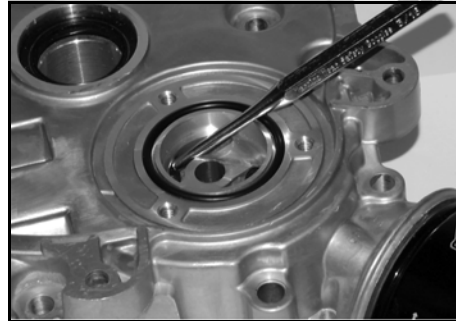


Figure 18

Install oil pump screen, until seated (Figure 19).

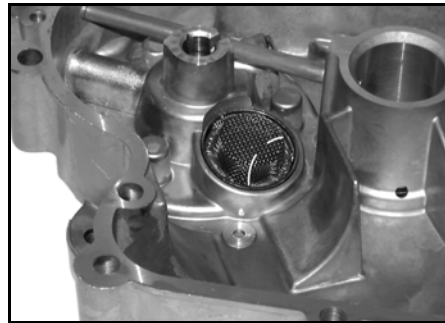


Figure 19

8

### Inspect Oil Pump Parts

1. Inspect surfaces of outer and inner rotors, pump housing, cover, and shaft for wear and scoring. Replace parts if necessary.
2. Inspect pump housing and passages for debris. Clean as required.
3. Inspect screen for clogging or damage. Replace as necessary.

### Install Screen and Gerotor Pump

1. Install pump screen until fully seated, or secure with screw, depending on design.
2. Insert drive shaft, if removed separately.
3. Pre-oil and install outer rotor (D, Figure 20) in pump cavity. Do not use force to install.
4. Pre-oil and install inner rotor (C) in pump cavity.
5. Turn rotor to engage pump in cam or governor gears.
6. Place o-ring (B) in groove in cover (E) or sump.

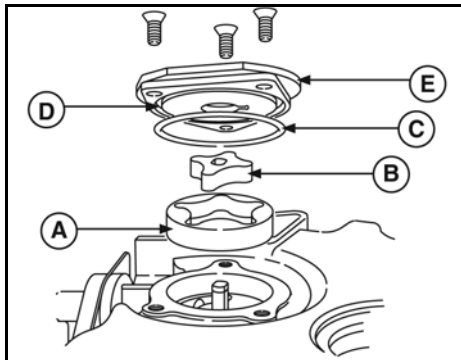


Figure 20

7. Place pump cover on oil pump cavity (Figures 21, 22, 23). Torque screws to values listed in Section 12 - Engine Specifications.

**NOTE:** Some covers have two notches that align with ribs in the pump cavity.

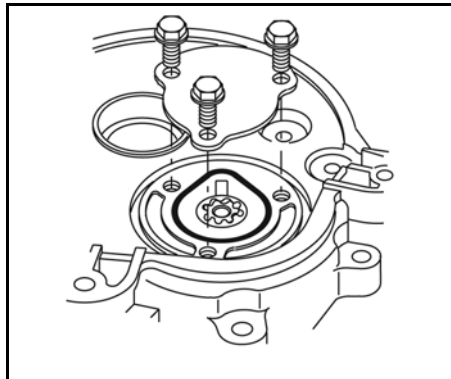


Figure 21

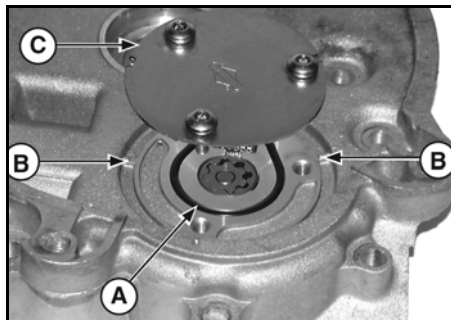


Figure 22

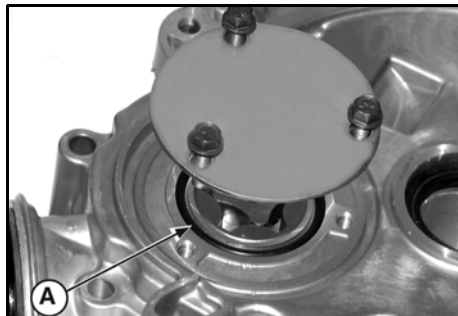


Figure 23

### Oil Filter and Adapters

#### Remove

1. Drain oil, unscrew filter (A, Figure 24) and discard.
2. Remove screws, filter adapter (B), and gasket. Discard gasket.

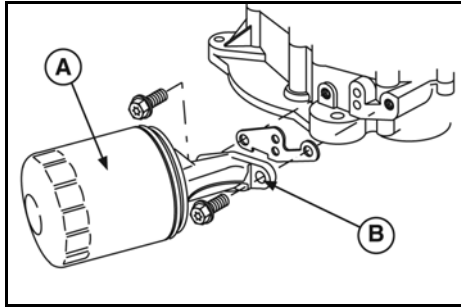


Figure 24

**Inspect**

1. Check adapter for cracks or damage to the sump and filter mounting surfaces. Replace adapter if necessary.
2. Clean all oil passages in adapter and in sump.

**Install**

1. Using new gasket, place adapter on sump and install screws. Torque screws to values listed in Section 12 - Engine Specifications.
2. Apply a thin film of clear oil filter gasket. Install filter until gasket contacts the adapter, then tighten 1/2 to 2/3 turn more.

**Oil Pressure Switch**

The optional low oil pressure switch is located on the sump or oil filter adapter (A, Figure 25).

The switch should open at approximately 4-5 PSI (.27-.34 bar) for Model Series 28N700, 28P700, 287700, 310700, 312700, 313700, 330700.

Model Series 28N777 Type 1194-E1 opens at approximately 9-13 PSI (.62 -.90 bar).

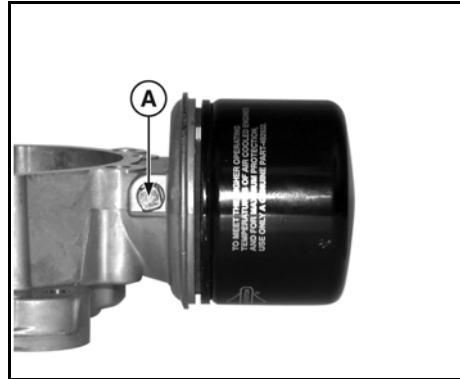


Figure 25

**Test Oil Pressure Switch**

1. Unscrew the switch to remove it for testing.
2. Connect one test meter lead to the switch terminal and the other lead to the metal body of the switch.
3. The meter should indicate continuity.
4. Replace the switch if there is no continuity.
5. Install switch and tighten to values given in Section 12 - Engine Specifications.

**NOTE:** Do not use sealing tape on the switch threads.

**Oil Gard Systems**

**Horizontal Model Series 110000, 120000, 150000, 200000, 210000**

The Oil Gard System consists of:

- Oil Sensor (A, Figure 26 and Figure 27) (located inside crankcase)
- Module (B)
- Three-terminal stop switch (C)
- Connecting wires

If the oil level is low, the Oil Gard sensor will close. The engine cannot be restarted until sufficient oil is added. If equipped with a lighted rocker switch, the light will flash when the starter is actuated, indicating insufficient oil in the crankcase.

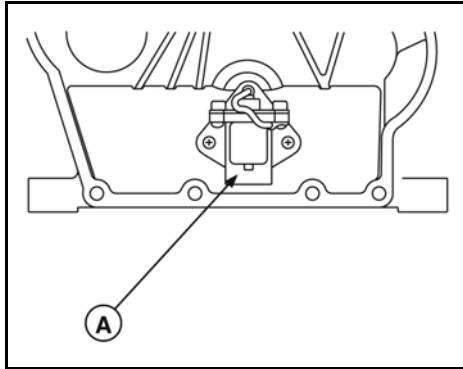


Figure 26

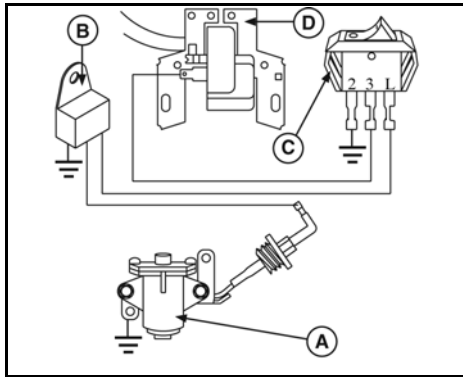


Figure 27

**8**

There are two types of Oil Gard systems in use:

- *Start Sense*
- *Run Sense*

**Identification**

*Start Sense* is designed to prevent the engine from starting if the oil level is too low. It will not start an engine that is already running.

Type of Starter	Lead Wire Colors
Rewind	Gray/Gray Yellow/Black
Electric	Yellow/Yellow

*Run Sense* will stop a running engine if the oil level runs below the ADD level on the dipstick.

The engine can be restarted, but will only run briefly.

Type of Starter	Lead Wire Colors
Rewind	Gray/Black White/Gray
Electric	Gray/Black White/Gray

**Troubleshooting**

In engines equipped with a *Start Sense* system, if the engine will not start, check oil level and bring level to FULL. If engine still does not start, disconnect lead at the oil fill plug/terminal. If engine starts, the module is faulty, or the internal crankcase float is sticking. Clean or replace parts as necessary.

In engines equipped with a *Run Sense* system, if the engine halts during operation, or will not remain running upon starting, check oil level. If oil level is at FULL and engine continues to halt, the module is faulty or the internal crankcase float is sticking. Clean or replace parts as necessary.

## SECTION 9 - CYLINDERS, COVERS AND SUMPS

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# CYLINDER

## Inspect Cylinder

1. Visually check cylinder for cracks, stripped threads, and bore damage.
  - If cracks are found, replace the cylinder.
  - Stripped threads can sometimes be repaired using a helicoil, but if multiple holes have thread damage, replace the cylinder.
  - Bore damage, if not severe, may be corrected by reconditioning or resizing (see below).

Check cylinder head mounting surface for distortion with a straight edge (Figure 1). If mounting surfaces are distorted more than 0.004" (0.1 mm), the cylinder must be replaced.

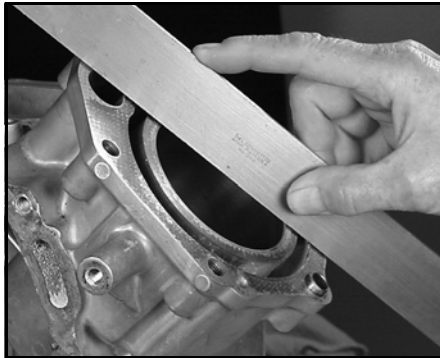


Figure 1

9

2. Check cylinder bore for wear using Telescoping Gauge #19485 and Dial Caliper #19199.

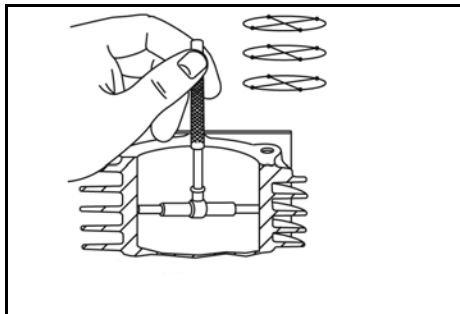


Figure 2

Measure twice (90° apart) at the top, center, and bottom of the piston ring travel (Figure 2).

Compare measurements to the standard cylinder bore sizes provided in Section 12 - Engine Specifications.

If the cylinder bore is more than 0.003" (0.08 mm) oversize, or 0.0015" (.04 mm) out of round, it must be resized.

## Reconditioning Bore

If cylinder bore is within specification and shows no signs of scoring or other damage, it can be reconditioned using a rigid hone with finishing stones to restore the proper crosshatch angle. The correct crosshatch of approximately 45° (Figure 3) ensures proper lubrication and piston ring break-in.

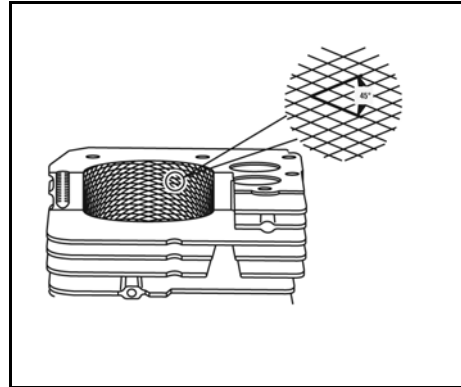


Figure 3

**NOTE:** IT IS MOST IMPORTANT THAT THE ENTIRE CYLINDER BE THOROUGHLY CLEANED AFTER HONING.

## Resizing Bore

Always resize to exactly .020" (.51 mm) larger than standard bore size. Done accurately, the service oversize rings and pistons will fit perfectly with proper clearances.

Cylinders can be quickly resized with Hone #19205 or #1921. Use the stones and lubrication recommended by the hone manufacturer to produce the sizing and finish.

**NOTE:** IT IS MOST IMPORTANT THAT THE ENTIRE CYLINDER BE THOROUGHLY CLEANED AFTER HONING.

### Cleaning Cylinder

1. Wash the cylinder thoroughly in a solvent such as kerosene or other commercial solvent.
2. Wash cylinder again using a stiff brush with soap and hot water.
3. Rinse cylinder thoroughly with hot running water.
4. Repeat washing and rinsing until all traces of honing grit are gone.

**NOTE:** Honing grit is highly abrasive and will cause rapid wear to all of the internal components of the engine.

When cylinder and crankcase have been thoroughly cleaned, use a clean white rag to wipe the cylinder bore. If honing grit is still present, it will appear as a grey residue on the rag. Re-wash and rinse entire cylinder then check again. When there is no trace of honing grit on the rag, the cylinder is properly cleaned. Oil the cylinder bore to prevent rusting.

## MAIN BEARINGS

### Check Bearings

Briggs & Stratton OHV engines are equipped with plain bearings machined into the cylinder or cover/sump, DU™ bearings, or ball bearings to support the crankshaft.

### Check Plain Bearings

Machined bearings are not repairable. If a machined bearing is scored or worn, the cylinder or cover/sump must be replaced.

### Check DU™ Bearings

Main bearings should be replaced if scored or if plug gauge (A, Figure 4) will enter bearing. Try gauge at several locations in bearing.

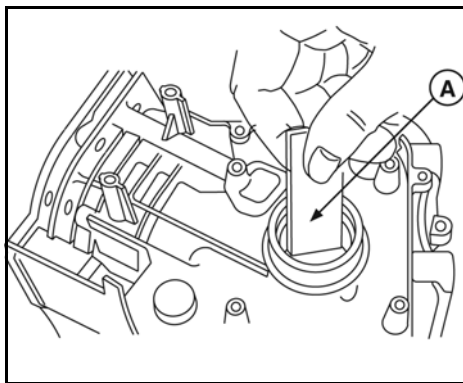


Figure 4

### Check Ball Bearings

Ball bearings must rotate freely. If any rough spots are felt, the ball bearing must be replaced (Figure 5).

**NOTE:** DO NOT reuse ball bearings. The bearing races are usually damaged during removal.

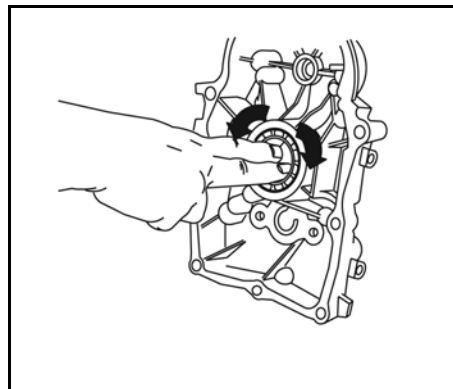


Figure 5

**NOTE:** Standard and reject sizes for the main bearings are shown in Section 12 - Engine Specifications.

### Check Camshaft Bearings

The camshaft is supported by machined bearings which are not serviceable. Check camshaft bearings with Plug Gauge #19164. If gauge can be inserted 1/4" (6.4 mm) or more,

replace the affected cylinder, crankcase cover, or sump (Figure 6).

**NOTE:** Standard and reject sizes for the main bearings are shown in Section 12 - Engine Specifications.

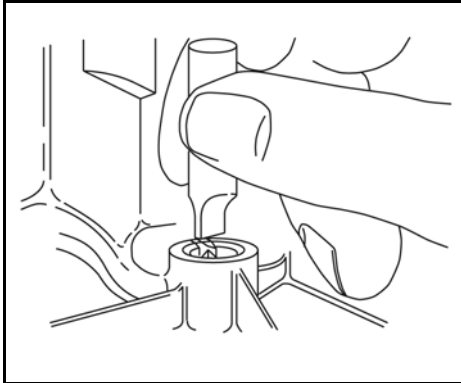


Figure 6

## Replace Bearings

### Replace DU™ Bearings

1. Select tools needed from Figure 7 and Figure 8.

Magneto Bearing Tools		
Model Series	Bushing Driver	Cylinder Support
110000 120000 All	19124	19123
150000 H/S	19124	19123
210000 H/S	19179	19227
210000 V/S	19450	19351
280000 V/S	19450	19227
310000 V/S	19450	19227
330000 V/S	19350	19351

Figure 7

PTO Bearing Tools		
Model Series	Bushing Driver	Cylinder Support
110000 120000 All	Replace Crankcase Cover or Sump	
150000 H/S	Replace Crankcase Cover	
210000 H/S	19179	19227
210000 V/S	Replace Sump	
280000 V/S	Replace Sump	
310000 V/S	Replace Sump	
330000 V/S	Replace Sump	

Figure 8

2. Remove and discard oil seal for bearing to be repaired.

**NOTE:** Before removing oil seal(s) note and record the depth of the oil seal from mounting surface so that the new seal is installed to the same depth.

3. Insert bushing driver tool (A, Figure 9) into bearing from oil seal side. Place a reference mark (B) on driver to indicate proper depth when installing the new bearing.

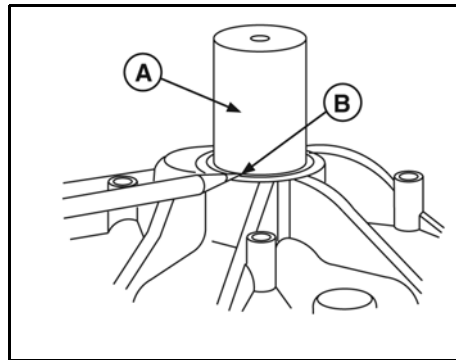


Figure 9

4. Place cylinder support tool (C, Figure 10) under cylinder or cover/sump bearing (B). Press driver until bearing is extracted.

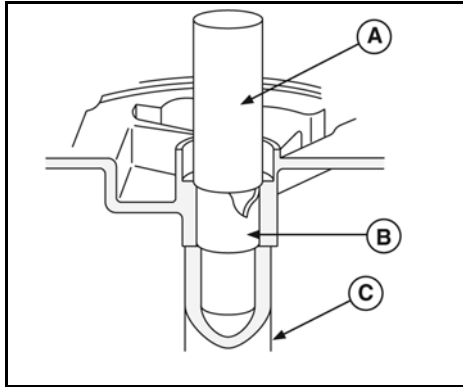


Figure 10

5. Place cylinder or cover/sump on cylinder support (B, Figure 11) with large opening facing bearing.
6. Align oil holes in bearing with oil holes in cylinder or cover/sump, then press in new bearing to correct depth with bushing driver (A).

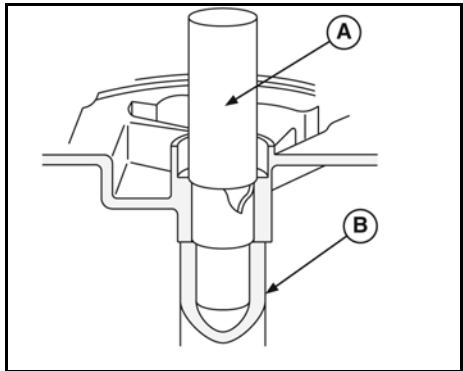


Figure 11

7. Stake bearing into notch (A, Figure 12) with 1/8" round pin punch to prevent bearing from turning.

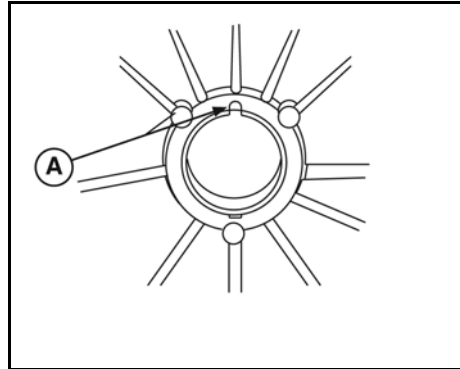


Figure 12

### Replace Ball Bearing

#### Horizontal Models 120000, 150000

1. Select tools needed from charts below.

Bearing Removal Tools	
Tool/Part Description	Tool/Part #
Washer	690582
Puller Screw	19318
Removal Driver	19320
Support	19454

Bearing Installation Tools	
Tool/Part Description	Tool/Part #
Washer	690582
Puller Screw	19318
Installation Driver	19396
Support	19454

2. Remove retaining ring and governor idler gear (A, Figure 13). Remove oil seal.

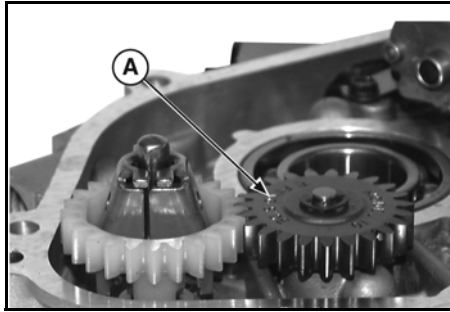


Figure 13

3. Assemble washer (C, Figure 14) to puller screw (D) and insert through large end of removal driver (B). Place open end of support (A) against ball bearing.
4. Insert screw with washer and driver through ball bearing and thread into support. Continue tightening screw until ball bearing is removed.

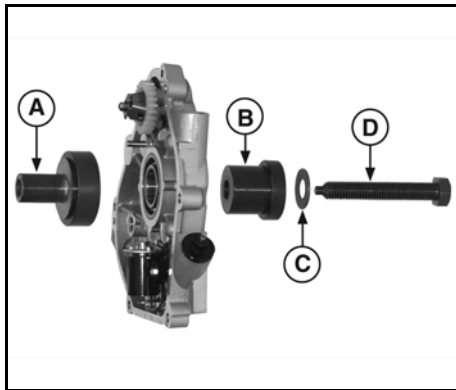


Figure 14

5. Lubricate outside diameter of new ball bearing. Place ball bearing on support (A, Figure 15).
6. Assemble washer (C) to puller screw (D). Insert large end pilot (B) into oil seal boss in crankcase cover.
7. Insert screw through pilot and thread into support. Tighten screw until ball bearing is seated.
8. Install new oil seal. Use large end of Driver #19320, and press in oil seal until flush with crankcase cover.
9. Install governor idler gear and E-ring.

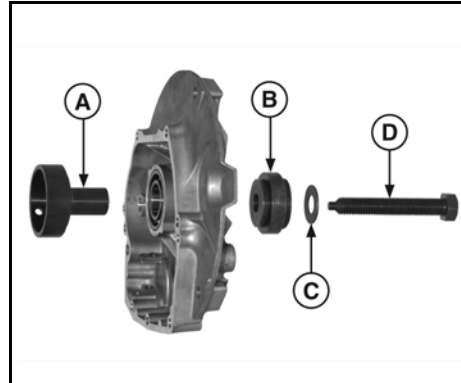


Figure 15

**NOTE:** Always install new oil seals when engine is reassembled or when replacing bearings. Always use the correct seal protector to prevent damaging the oil seal during installation.

### Replace Ball Bearing

#### Horizontal Models 200000, 210000

1. Select tools needed from charts below.

Bearing Removal Tools	
Tool/Part Description	Tool/Part #
Washer	690582
Puller Screw	19318
Removal Driver	19401
Removal Support	19440

Bearing Installation Tools	
Tool/Part Description	Tool/Part #
Washer	690582
Puller Screw	19318
Installation Driver	19396
Installation Support	19394

2. Remove retaining ring and governor idler gear. Remove oil seal.
3. Assemble washer (C, Figure 16) to puller screw (D) and insert through small end of removal driver (B). Place open side of support (A) against ball bearing with cutout over idler gear shaft.

4. Insert screw, with washer and driver through the ball bearing and thread into support. Continue tightening screw until ball bearing is removed.

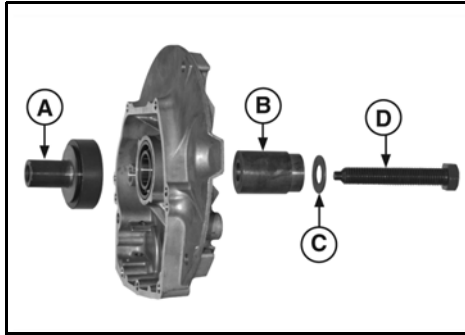


Figure 16

5. Lubricate outside diameter of new ball bearing. Place ball bearing on support (A, Figure 17).
6. Insert small end of installation driver (B) in oil seal bore. Assemble washer (C) to puller screw (D).
7. Insert screw through pilot and thread into support. Tighten screw until ball bearing is seated.
8. Install new oil seal. Use large end of Driver #19320, and press in oil seal until flush with crankcase cover.
9. Install governor idler gear and E-ring.

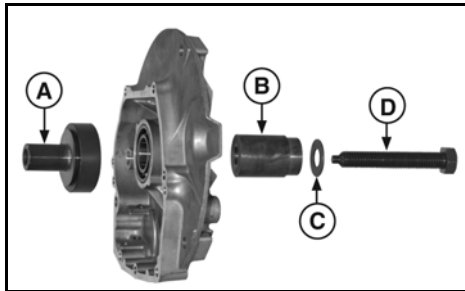


Figure 17

**NOTE:** Always install new oil seals when engine is reassembled or when replacing bearings. Always use the correct seal protector to prevent damaging the oil seal during installation.

### Replace Ball Bearing

#### All Vertical Models

1. Select tools needed from charts below.

Bearing Removal Tools	
Tool/Part Description	Tool/Part #
Washer	690582
Puller Screw	19318
Removal Driver	19401
Removal Support	19454

Bearing Installation Tools	
Tool/Part Description	Tool/Part #
Washer	690582
Puller Screw	19318
Installation Driver	19396
Installation Support	19454

2. Remove oil seal.
3. Assemble washer (C, Figure 18) to puller screw (D). Insert puller screw and washer through small end of driver (B). Insert from outside of sump against inner race of ball bearing. Place large end of support (A) over ball bearing.
4. Insert screw with washer and driver through ball bearing and thread into support. Continue tightening screw until ball bearing is removed.

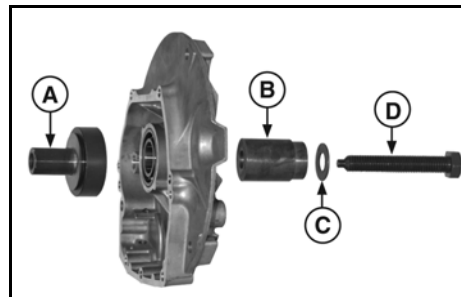


Figure 18

5. Lubricate outside diameter of ball bearing. Place ball bearing on support (A, Figure 19).
6. Insert large end of driver (B) into oil seal bore. Place washer (C) on puller screw (D).
7. Insert screw through drive and thread into support. Tighten screw until ball bearing is seated.
8. Install new oil seal. Use large end of Driver #19401 to press in oil seal to 3/16" (4.7mm) depth.

9

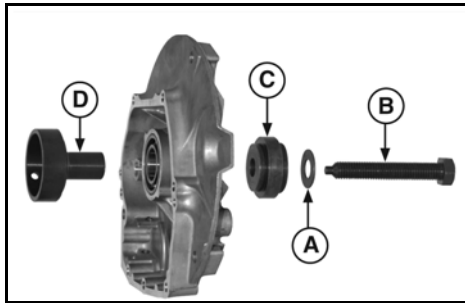


Figure 19

**NOTE:** Always install new oil seals when engine is reassembled or when replacing bearings. Always use the correct seal protector to prevent damaging the oil seal during installation.

## COVERS AND SUMPS

### Installation

1. Select correct seal protector for Kit #19356, to protect oil seal when installing cover or sump.
2. Make sure mechanical governor gear and oil pump (when used) is engaged with cam gear. Do not force cover or sump.
3. Install screws and tighten in sequence shown:
  - Figure 20 - Vertical Shaft Models 97700 and 99700
  - Figure 21 - Vertical Shaft Models 110000 and 120000.
  - Figure 22 - Vertical Shaft Models 210000, 280000, 310000, and 330000.
  - Figure 23 - Horizontal Shaft Models 120000 and 150000.
  - Figure 24 - Horizontal Shaft Models 200000 and 210000.
4. Torque screws to values listed in Section 12 - Engine Specifications.

**NOTE:** To adjust crankshaft end play, see Section 10 - Crankshafts and Camshafts.

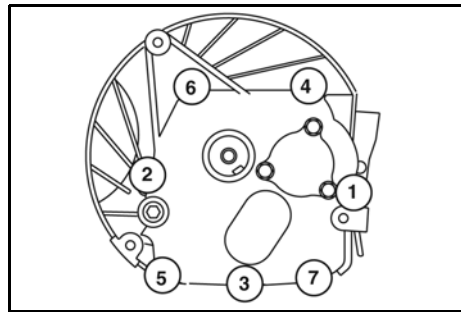


Figure 20

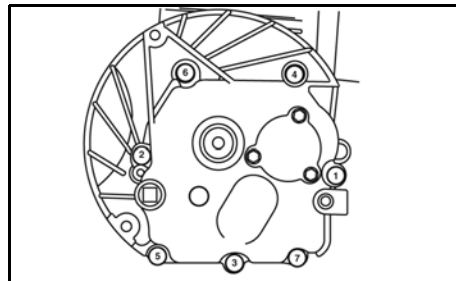


Figure 21

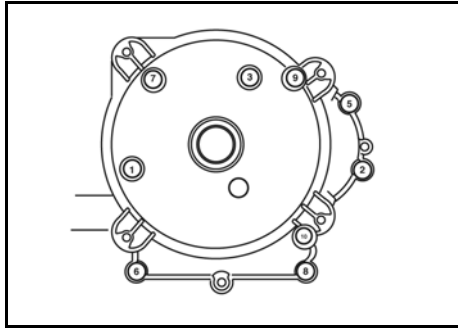


Figure 22

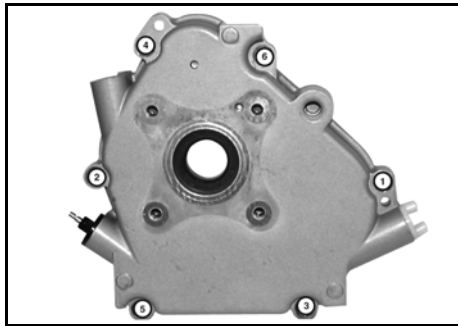


Figure 23

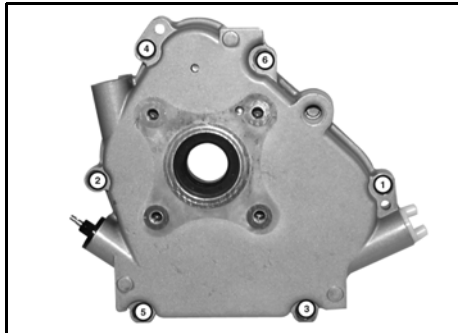


Figure 24

9



9

## **SECTION 10 - CRANKSHAFTS, CAMSHAFTS, BALANCING SYSTEMS, AND GEAR REDUCTIONS**

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## CRANKSHAFTS AND CAMSHAFTS

### Remove Crankshaft and Camshaft

1. Drain oil from engine and all fuel from fuel tank. Drain oil from gear reduction unit (if equipped) and remove from engine (A, Figure 1).
2. Remove blower housing/rewind assembly and flywheel/fan assembly.
3. Remove burrs and clean crankshaft, then remove crankcase cover or sump. Set aside.

**NOTE:** If crankcase cover or sump sticks, tap lightly with soft hammer on alternate sides near dowel pins (B). It is not necessary to remove dowel pins.

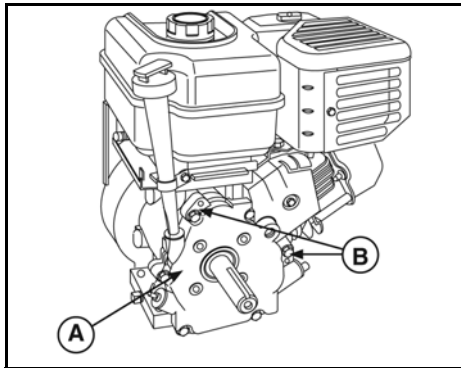


Figure 1

4. Carefully tip engine with PTO-end facing up.
5. Rotate crankshaft until timing marks (A, Figure 2) are aligned. With camshaft in this position, the valve tappets will remain clear of cam lobes. Lift out camshaft (B).

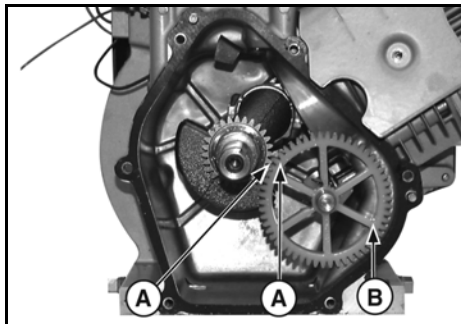


Figure 2

6. Rotate crankshaft to place piston at Top Dead Center (TDC).
7. Remove connecting rod cap, then slide out crankshaft.

### Inspect

#### Check Crankshaft

1. Inspect crankshaft for scoring on mag journal (A, Figure 3), crankpin journal (B), and PTO journal (C). Replace crankshaft if scoring is found or if crankshaft is bent. DO NOT attempt to straighten bent crankshafts.

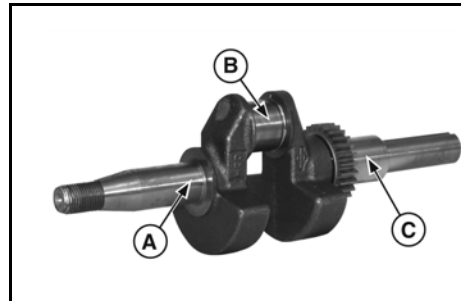


Figure 3

2. Using a dial caliper, measure the journal diameters and balancer eccentrics (if equipped). Compare results to values listed in Section 12 - Engine Specifications. If wear exceeds the reject dimensions, replace the crankshaft.

#### Check Camshaft

1. Check gear (A, Figure 4) for worn or damaged teeth. Check lobes (D) and journals (B, C) for scratching or scoring. Check compression release mechanism (A, Figure 5) for wear, burrs, or sticking. Replace camshaft if any of these conditions are found.

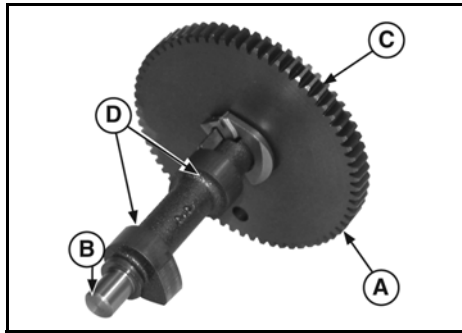


Figure 4

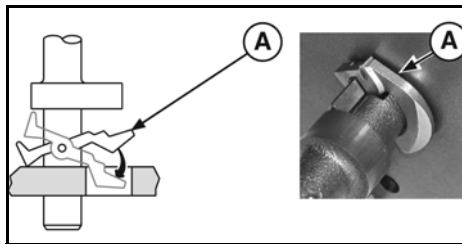


Figure 5

- Using a dial caliper, measure the journal diameters and cam lobes. Compare results to values listed in Section 12 - Engine Specifications. If wear exceeds the reject dimensions, replace the camshaft.

### Install Crankshaft and Camshaft

- Lubricate the cylinder bearing/oil seal with engine oil.
- Install intake and exhaust valve tappets.
- Support both ends of the crankshaft, and carefully install into the cylinder.

**NOTE:** The counterbalance system, if equipped, must be assembled to the crankshaft before installing into the cylinder.

- Assemble connecting rod assembly to crankshaft.
- Install the timing gear to the crankshaft with timing mark out. The flange of the gear must face the counterweight link, if equipped.
- Install camshaft, making sure tappets clear cam lobes. Timing marks (A, Figures 6, 7, 8) must align.

- On horizontal crankshaft engines, make sure the paddle on the governor shaft (B, Figure 6) is rotated in line with the governor cup inside the crankcase cover.
- On vertical crankshaft engines, assemble governor gear/oil slinger (B, Figures 7 and 8) to camshaft. Make sure the paddle on the governor shaft is contacting the governor cup (C).

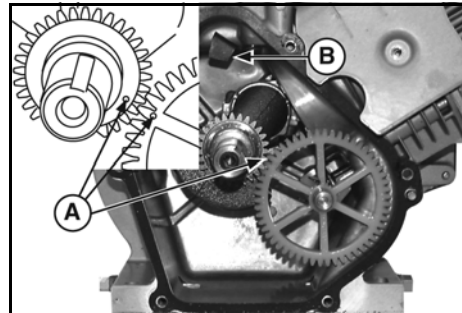


Figure 6

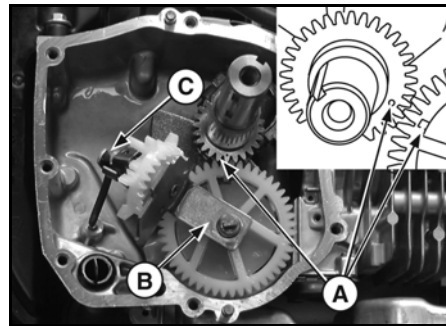


Figure 7

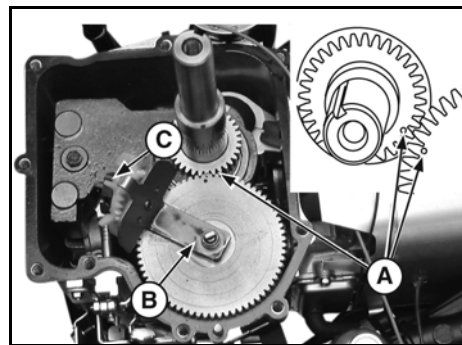


Figure 8

## Install Crankcase Cover or Sump

1. Using a new gasket install crankcase cover or sump using seal protectors. Do not force cover or sump on cylinder.

**NOTE:** It may be necessary to rotate crankshaft to get oil pump (if equipped) to engage drive slot in camshaft. For horizontal crankshafts, it may be necessary to rotate idler gear to mesh with timing gear when installing cover.

2. Install screws in sequence shown in Figures 9, 10, 11, and 12.
  - Figure 9 - Horizontal shaft models 120000, 150000, 200000, 210000
  - Figure 10 - Vertical shaft models 97700, 99700
  - Figure 11 - Vertical shaft models 120000, 210000
  - Figure 12 - Vertical shaft models 280000, 310000, 330000
3. Torque to values listed in Section 12 - Engine Specifications.

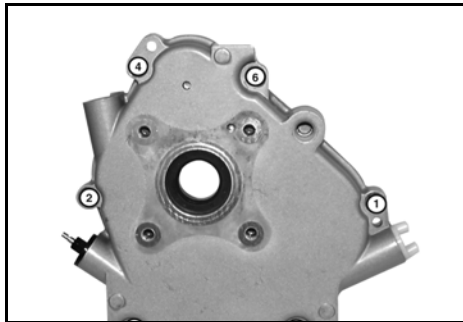


Figure 9

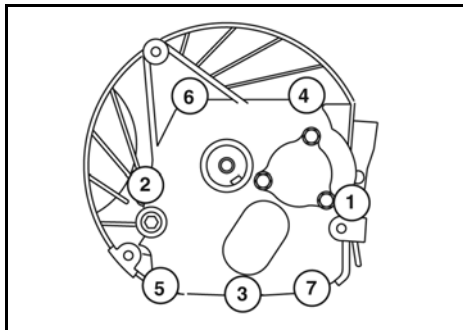


Figure 10

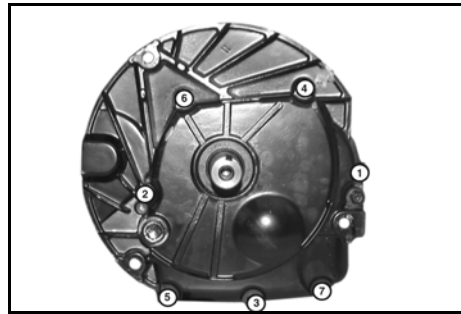


Figure 11

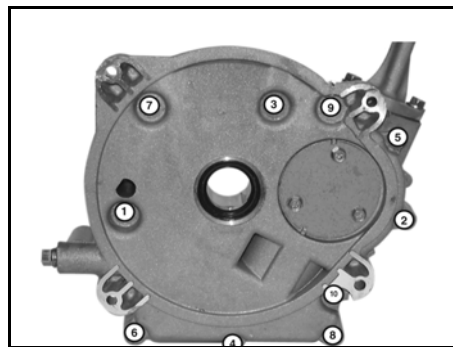


Figure 12

**NOTE:** Screws assembled at position 4, Figure 10 and position 9, Figure 12 were coated with sealant. If sealant is missing, coat with a non-hardening sealant such as Permatex® 2, or equivalent.

## Check and Adjust Crankshaft End Play

When crankcase cover or sump is installed with a standard gasket, end play should match values listed in Section 12 - Engine Specifications.

If end play is less than specified, remove cover or sump and install an additional gasket. Do not use more than two gaskets.

If end play is more than specified, remove cover or sump and install a shim per the Illustrated Parts List, or replace the cover or sump.

**NOTE:** If using shims, install as follows:

- Models 120000, 150000 Vertical and Horizontal Engines - install shim on magneto-end of crankshaft (A, Figure 13).
- Models 97700, 99700 Vertical Engines - use additional gaskets to get proper end play (A, Figure 14).
- Models 200000, 210000 Horizontal Engines - install shim on PTO-end of crankshaft (A, Figure 15).
- Models 210000, 280000, 310000, 330000 Vertical Engines - install shim on PTO-end of crankshaft between the timing gear and crankpin (A, Figure 16).

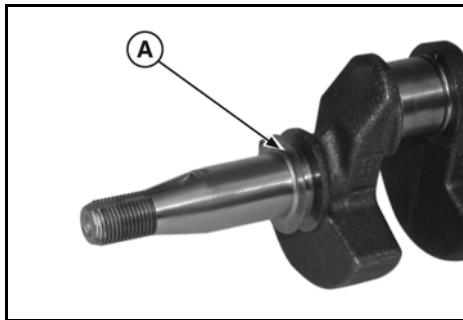


Figure 13

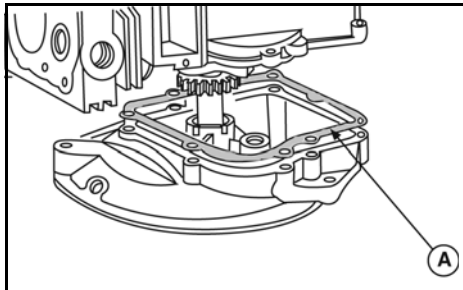


Figure 14

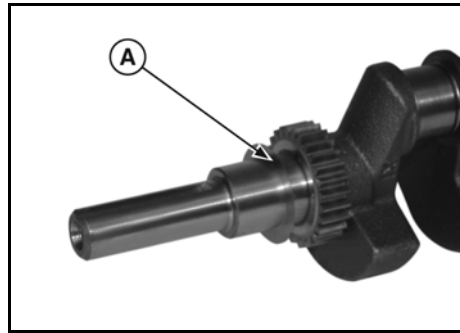


Figure 15

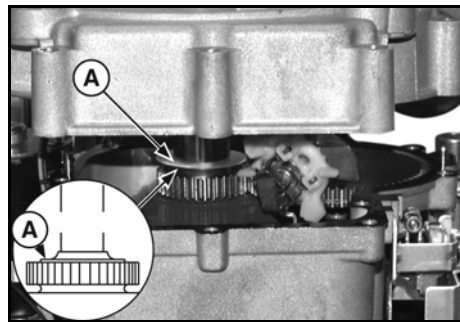


Figure 16

## GEAR REDUCTION

### Disassemble Gear Reduction

1. Note orientation of gear reduction assembly on engine. Place an oil collection pan beneath the assembly.
2. Remove oil vent plug (C, Figure 17) and set aside.
3. Loosen four cap screws (D) that secure the gear case cover assembly. Pull cover (A) away from gear case (B) and allow oil to drain into pan.
4. After gear case is drained, remove screws and cover.

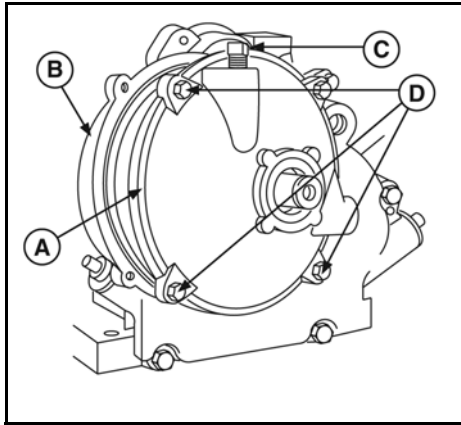


Figure 17

5. Remove drive shaft assembly (A, Figure 18) from gear case (B).
6. Bend down two screw locks (C), if equipped. Remove four cap screws. Slide gear case off engine.

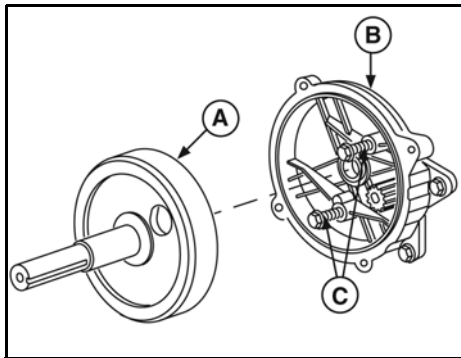


Figure 18

### Inspect Gear Reduction Parts

1. Inspect seals for cracks, tears, or hardening. Replace seals if necessary.
2. Inspect crankshaft pinion gear and drive shaft gear for worn, cracked, or chipped teeth. Replace if damaged or worn.
3. Inspect gear case and cover for cracks, damaged mounting, or damaged gasket surfaces. Replace if damaged.

### Assemble Gear Reduction

1. If replacing seals, install with sealing lip (A, Figure 19) toward engine side of gear case (B) or cover (C) until seal is flush with gear case or cover.

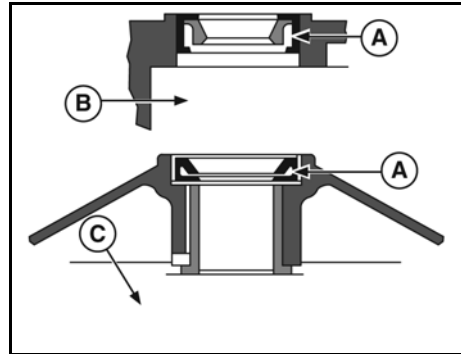


Figure 19

**NOTE:** The gear reduction assembly must be installed in the same orientation as noted prior to removal.

1. Insert two long screws and screw locks (A, Figure 20), if equipped, with tabs against the ribs of gear case.
2. Install new gasket, if used, on outside of gear case.
3. Slide gear case over crankshaft and against crankcase cover.
4. Hand tighten two long screws inside gear case.
5. Install and hand tighten two short screws with lock washers to the outside of gear case (B).
6. Torque the four screws to values listed in Section 12 - Engine Specifications.

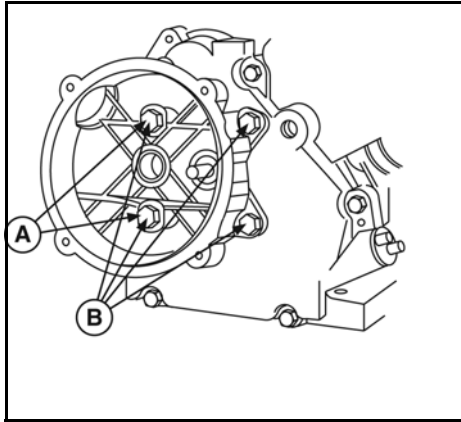


Figure 20

7. Install pinion gear on crankshaft.
8. Slide drive shaft assembly into gear case bearing and rotate to engage crankshaft pinion gear.
9. Place new gasket on gear case assembly.
10. Slide cover over drive shaft until seated on new gasket.

**NOTE:** Vent plug hole must be positioned at top.

11. Install four cover screws (A, Figure 21) and torque to values listed in Section 12 - Engine Specifications.

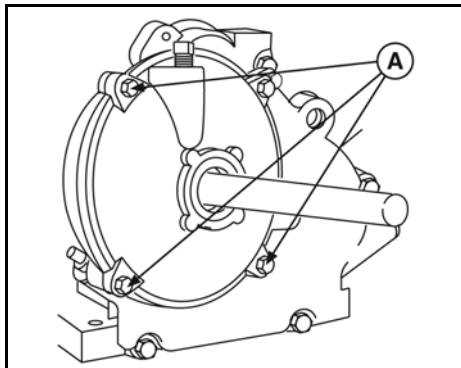


Figure 21

### Fill Gear Case with Lubricant

1. Remove oil level plug (C, Figure 22) and vent plug (A).
2. Fill gear case with SAE oil:
  - Above 40°F (10°C) use 80w90 for Horizontal Models 120000, 150000.
  - Above 40°F (10°C) use 30w for Horizontal Models 200000, 210000.
  - Below 40°F (10°C) use 10w30 for all gear reductions.
3. Fill gear case just to the point of overflowing at the oil level hole (B).
4. Install and tighten both plugs securely. Ensure that the vent plug (with hole) is installed at the top of the cover.

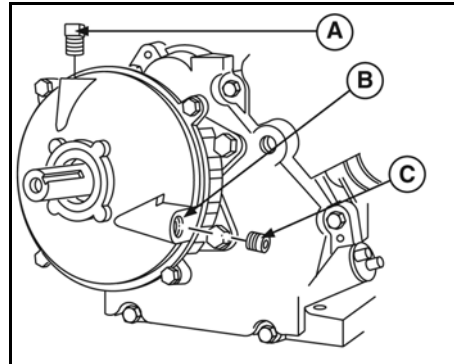


Figure 22



## AUXILIARY PTO

Some models of the vertical shaft 110000 and 120000 engines were equipped with an auxiliary PTO shaft. The auxiliary PTO shaft (E, Figure 23) extends through the side of the sump, perpendicular to the crankshaft. Rotation can be either clockwise or counterclockwise, as viewed from the end of the shaft. The oil slinger (A), camshaft (C), and worm gear (D) are pre-assembled and must be serviced as a set.

**NOTE:** The clockwise system requires a thrust washer (B) installed at the upper camshaft journal. The counterclockwise system requires the thrust washer be installed at the lower journal, under the worm gear.

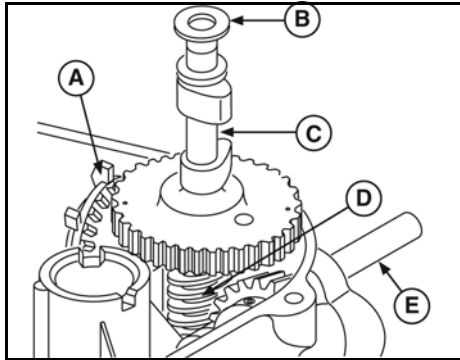


Figure 23

### Remove Auxiliary PTO Drive Shaft

1. Remove all rust and burrs from crankshaft, then remove sump.
2. To remove auxiliary PTO shaft from sump, remove Allen screw (A, Figure 24) from bottom of sump. The slinger, camshaft, and worm gear assembly will remain in the cylinder.

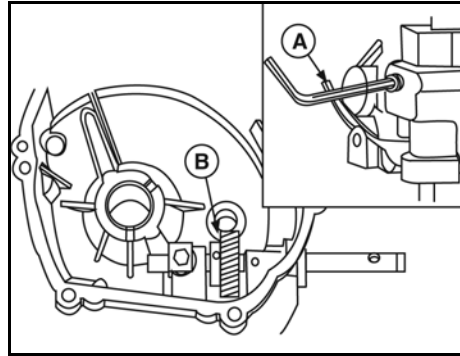


Figure 24

3. With a 3/16" pin punch, drive the roll pin in the bevel gear (B) through the allen screw hole.
4. Remove screw and PTO shaft stop then slide out PTO shaft.

### Inspection

Inspect all parts for evidence of wear or damage. If replacement is required, ensure the correct rotation set (clockwise or counterclockwise) is chosen from the Illustrated Parts List.

### Assemble Auxiliary PTO Drive Shaft

1. Place drive shaft in sump and push shaft through bevel gear.
2. Line up holes in bevel gear and drive shaft. Install new roll pin until it is centered in gear.
3. Place shaft stop in groove of drive shaft and install screw. Torque to values listed in Section 12 - Engine Specifications.
4. Install allen screw in bottom of sump and torque to values listed in Section 12 - Engine Specifications.
5. Rotate assembly by hand to check for binding.
6. Using new gasket, install sump to cylinder according to instructions provided earlier in this section.

## COUNTERBALANCE SYSTEMS

Two styles of counterbalance systems are used on Vertical crankshaft engines.

Models 280000 and 310000 (built before July 2001) have the Synchro-Balance® system. Models 280000 and 310000 built July 2001 and later, and all models 210000 and 330000 have the AVS® system. Both systems use a counterweight that oscillates opposite the direction of the piston, to reduce engine vibration (Figure 25).

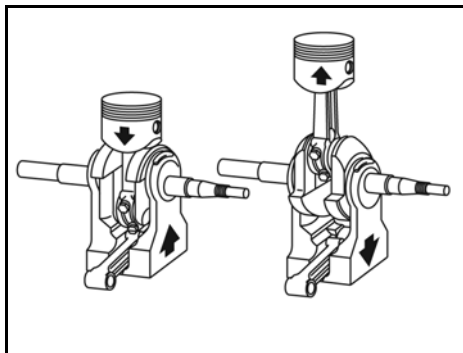


Figure 25

### Synchro-Balance® System

#### Remove Counterbalance System

1. Remove blower housing, flywheel, cylinder head, and sump. Discard gaskets.
2. Remove connecting rod and piston assembly.
3. Remove crankshaft and counterweight assembly.

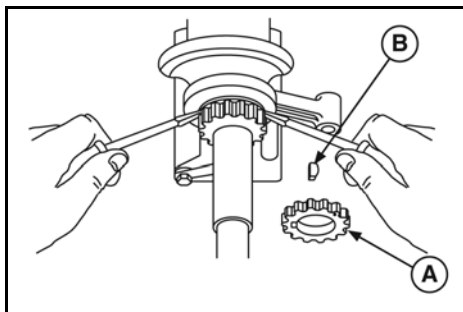


Figure 26

#### Disassemble

1. Remove crankshaft gear (A, Figure 26).

**NOTE:** If gear is tight, pry it off using two screwdrivers being careful not to damage gear.

2. Woodruff key (B) can be removed, if required.
3. Remove screw (A, Figure 27) from counterweight.
4. Remove PTO counterweight (B), dowel pin (C), and link (D) from crankshaft.
5. Remove crankshaft from magneto counterweight (E).

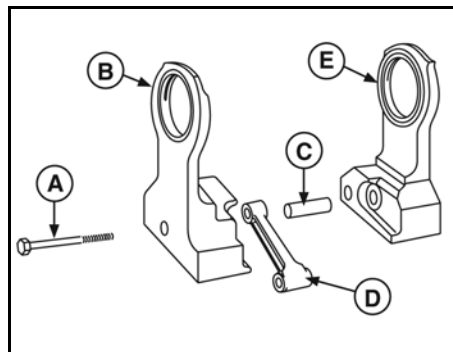


Figure 27

#### Inspect

1. Visually inspect counterweight bearings for scoring or discoloration. If found, replace both counterweights as a set.
2. Measure the counterweight bearing diameters and compare to the values shown in Section 12 - Engine Specifications. If either bearing is worn beyond the reject dimensions, replace both counterweights as a set.
3. Measure the crankshaft eccentric diameters and compare to the values shown in Section 12 - Engine Specifications.
4. If crankshaft eccentrics are worn, scored, or discolored, replace the crankshaft.

### Assemble

1. Lubricate all bearing surfaces with clean engine oil.
2. Slide magneto-side counterweight (A, Figure 28) on flywheel end of crankshaft.
3. Place crankshaft and counterweight in a vise with soft jaws or shop rags to protect magneto journal.
4. Slip link (C) over dowel pin (D) with rounded edge (E) up. Fit dowel pin into magneto counterweight.
5. Slide PTO counterweight (F) on dowel pin and crankshaft eccentric (G).
6. Install and torque screw (H) to value listed in Section 12 - Engine Specifications.

**NOTE:** Rotate counterweight assembly to check for binding. If binding exists, loosen and re-torque screw. Check again for binding.

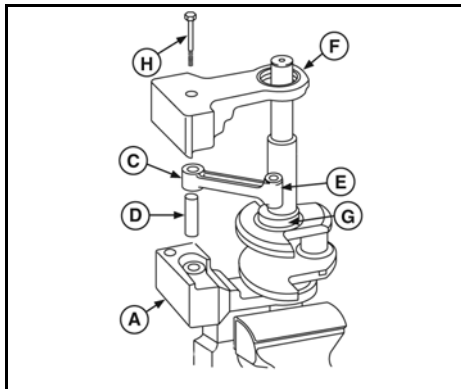


Figure 28

### Install

1. If woodruff key was removed, install in crankshaft.
  2. Slide timing gear onto crankshaft with chamfer toward eccentric.
- NOTE:** If gear is tight, it can be expanded slightly by heating on a lamp.
3. Place crankshaft and counterweight assembly into cylinder and start magneto journal into magneto bearing.
  4. Align link (A, Figure 29) with crankcase link pin (B) and push assembly into place.
  5. Install connecting rod and piston. Torque rod screws to values listed in Section 12 - Engine Specifications.

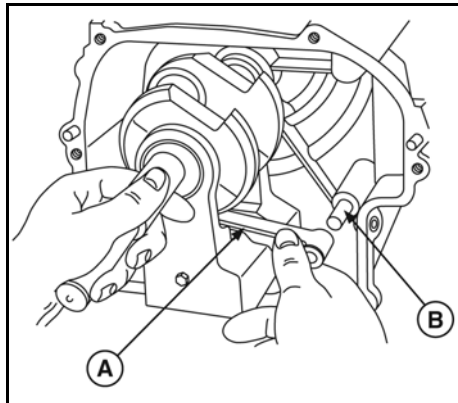


Figure 29

**NOTE:** Install connecting rod and piston. Lubrication hole in rod must face toward magneto side. Torque rod screws to values listed in Section 12 - Engine Specifications.

6. Using new gaskets, install sump, cylinder head, flywheel, and blower housing.

## AVS® Balance System

### Remove

1. Remove blower housing, flywheel, cylinder head, and sump. Discard gaskets.
2. Remove connecting rod and piston assembly.
3. Remove crankshaft and counterweight assembly.

### Disassemble

1. Remove the crankshaft gear (F, Figure 30) from the crankshaft (A). If the gear is tight, pry it off using two screwdrivers, being careful not to damage the gear.
2. The woodruff key (E) can be removed, if required.
3. Remove and discard the plastic alignment plug (C) from the magneto side of the counterweight (D).
4. Slide the counterweight from the counterweight links (B).
5. Remove PTO link and magneto link from crankshaft.

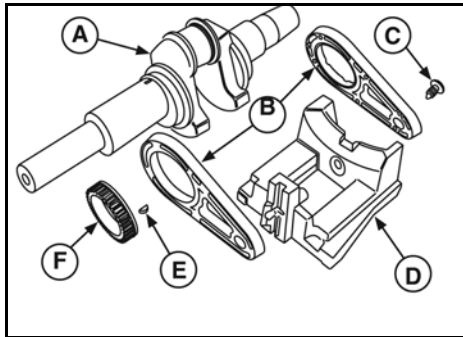


Figure 30

### Inspect

1. Visually inspect counterweight bearings for scoring or discoloration. If found, replace both counterweights as a set.
2. Measure the counterweight bearing diameters and compare to the values shown in Section 12 - Engine Specifications. If either bearing is worn beyond the reject dimensions, replace both counterweights as a set.

3. Measure the crankshaft eccentric diameters and compare to the values shown in Section 12 - Engine Specifications.
4. If crankshaft eccentrics are worn, scored, or discolored, replace the crankshaft.

### Assemble

1. Lubricate all bearing surfaces with clean engine oil.
2. Slide the counterweight links on the crankshaft eccentrics.

**NOTICE:** Both links must be installed with the chamfered side facing the crankshaft crankpin.

3. Slide the counterweight into the counterweight links.
4. Press a new plastic alignment plug into the magneto side of the counterweight.

### Install

1. Install the woodruff key to the crankshaft.
2. Install the timing gear to the crankshaft with timing mark out. The flange of the gear must face the counterweight link.
3. Place crankshaft and counterweight assembly into the cylinder and start magneto journal into magneto bearing.
4. Install connecting rod and piston. Torque rod screws to values listed in Section 12 - Engine Specifications.

**NOTE:** Lubrication hole in rod must face toward magneto side.

5. Using new gaskets, install sump, cylinder head, flywheel, and blower housing.

10

## **SECTION 11 - PISTONS, RINGS AND CONNECTING RODS**

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## PISTONS, RINGS, & CONNECTING RODS

### Remove Piston and Connecting Rod

1. Carefully remove any carbon or ridge at top of cylinder bore to prevent ring breakage.
2. Remove rod bolts and connecting rod cap (A, Figure 1).
3. Push piston and rod assembly out through top of cylinder bore.

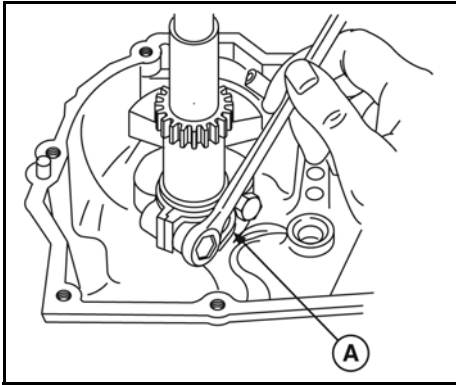


Figure 1

### Disassemble

1. Rotate pin retainer until one end is exposed in notch in pin bore.
2. Remove the two retainer pins (A, Figure 2) with needle nose pliers.

**NOTE:** Some pistons have a shoulder stop on one side and a single retainer.

3. Slide out pin (B) from opposite side and remove connecting rod from piston.

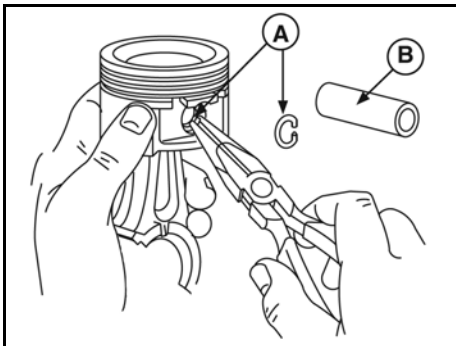


Figure 2

4. Using Piston Ring Expander #19340 (Figure 3), remove rings one at a time. Note the order and orientation of the rings before removal.

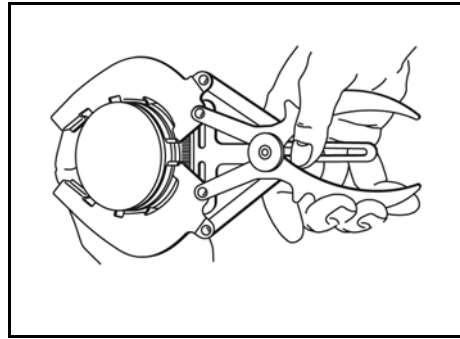


Figure 3

**NOTE:** Some oil control rings consist of two thin steel rails and a spring expander. These must be removed by hand as follows:

- Grasp one end of the upper steel rail and wind the rail from the oil ring groove into the center ring groove. Repeat into the top ring groove and then off the piston.
- Remove the spring expander, then remove the lower steel rail.

### Inspect

#### Check Piston and Pin

1. Inspect piston for scoring, galling, or other damage. Replace piston if necessary.
2. Using a dial caliper or plug gauge, measure the pin bore diameter. Compare with reject dimensions listed in Section 12 - Engine Specifications. If pin bore exceeds reject dimensions, replace the piston.
3. Measure outside diameter of pin and compare to the reject dimension listed in Section 12 - Engine Specifications. If pin is smaller than the reject dimension, replace the pin.
4. Clean carbon from top ring groove.
5. Place NEW ring in groove (Figure 4) and, using a feeler gauge, measure space between ring and ring land. Compare with reject dimensions listed in Section 12 -

Engine Specifications. If clearance is greater than shown the piston must be replaced.

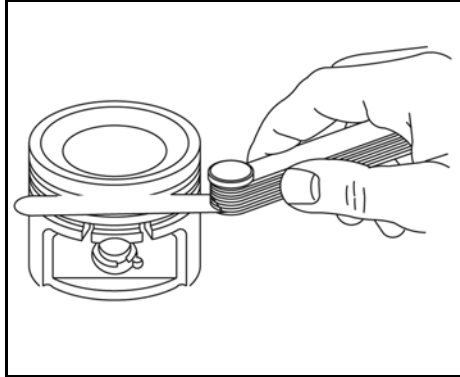


Figure 4

### Check Ring End Gap

It is recommended that the entire ring set be replaced when servicing the piston and/or cylinder bore. However, the original rings can be re-used if they are not damaged and are checked as follows:

1. Clean all carbon from the rings and the cylinder bore.
2. Insert an original ring (A, Figure 5) approximately one inch down into the cylinder bore.
3. Check end gap with feeler gauge. Compare with reject dimensions listed in Section 12 - Engine Specifications. If gap of any of the rings exceeds the reject dimension, all rings should be replaced.

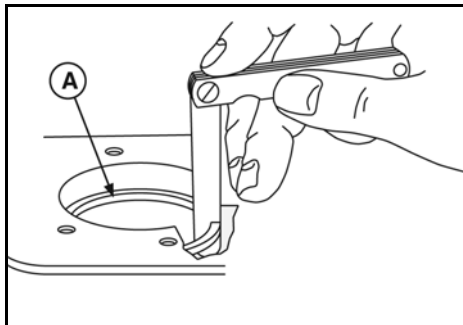


Figure 5

### Check Connecting Rod

If the crankpin bearing (A, Figure 6) or the piston pin bearing (B) is scored, the rod must be replaced.

1. Reinstall rod cap and bolts on rod.
2. Using a dial caliper or plug gauge, measure the two bearing diameters. Compare with reject dimensions listed in Section 12 - Engine Specifications. If either bearing exceeds the reject dimensions, the rod must be replaced.
3. Remove rod bolts and rod cap. Set aside.

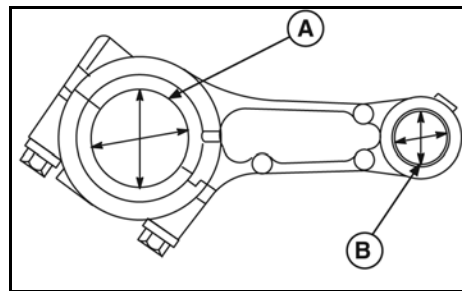


Figure 6

### Assemble

1. Install a pin retainer into one groove in piston bore. Skip this step if piston has a shoulder stop on one side.
2. Oil the piston pin bore, connecting rod pin bore, and the pin. Insert rod into piston, then slip pin through piston and rod bores until it seats against the retainer or shoulder stop.

**NOTE:** The notch or arrow (A, Figure 7) on the piston and "MAG" on the rod (B) must face the same direction. When installed in engine, the notch will face the flywheel.

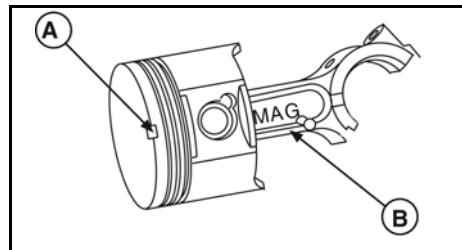


Figure 7



**NOTE:** For Vertical Model 120000 ONLY, install piston with notch or arrow (**A**, Figure 8) facing away from “MAG” on the rod. When installed in engine, the notch will face the PTO.

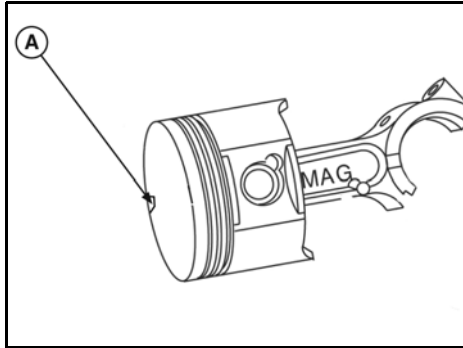


Figure 8

3. Install a pin retainer into groove on open side of piston pin bore. Ensure retainers are firmly seated in grooves.
4. Using Piston Ring Expander #19340, install oil ring and spring expander, then the center ring, then the top ring. Follow the orientation noted at time of disassembly, or use the instructions provided if installing a new ring set.

**NOTE:** If oil ring consists of two steel rails and a spring expander, they must be installed by hand as follows:

- Grasp one end of lower steel rail and wind it over the top ring groove, then into the center ring groove, and finally into the oil ring groove.
- Install the spring expander on top of the lower rail, then install the upper steel rail.

### Install Piston and Connecting Rod

1. Thoroughly clean and oil cylinder bore and crankpin journal.
2. Rotate crankshaft until crankpin journal is at bottom of stroke.
3. Using Ring Compressor Tool #19070 or #19230, install piston with notch or arrow (**A**, Figure 9) toward flywheel side of engine, taking care not to damage crankpin journal or connecting rod bearing.

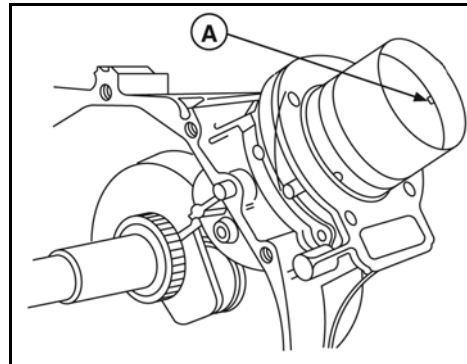


Figure 9

4. Fit connecting rod bearing on crankpin journal, then install rod cap with match marks aligned.
5. Cap should snap into position when assembled correctly. Install rod screws (and dipper, if equipped).
6. Tighten screw closest to piston (**A**, Figure 10) first, then screw farthest from piston (**B**) second. Torque screws to values listed in Section 12 - Engine Specifications.

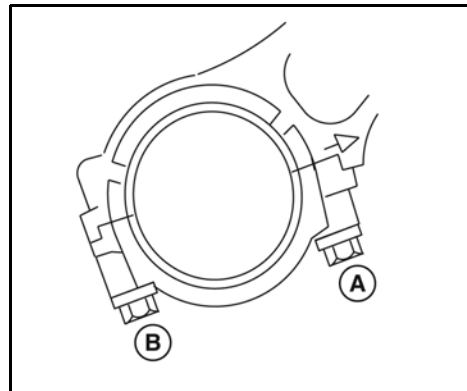


Figure 10

**NOTE:** Failure to use a torque wrench can result in loose rods causing breakage, or over-tightened rods causing scoring.

7. Rotate crankshaft two revolutions to ensure crankpin and rod do not bind.
8. Move connecting rod sideways to ensure rod has clearance on crankpin side.

## SECTION 12 - ENGINE SPECIFICATIONS

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## MODEL 110000 HORIZONTAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .028 in. (.05 - .71 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.004 - .006 in. (.10 - .15 mm)
Valve Clearance – Exhaust	.009 - .011 in. (.23 - .28 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base / Backplate	40 lb-in. (5 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Bracket to Carburetor (Snow)	45 lb-in. (5 Nm)
Carburetor Bowl Screw	90 lb-in. (10 Nm)
Carburetor to Cylinder Head	85 lb-in. (10 Nm)
Connecting Rod	100 lb-in. (11 Nm)
Control Bracket	100 lb-in. (11 Nm)
Control Panel Trim	40 lb-in. (5 Nm)
Crankcase Cover	100 lb-in. (11 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Head Plate	100 lb-in. (11 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	180 lb-in. (20 Nm)
Flywheel Nut	100 lb-ft. (135 Nm)
Flywheel Fan	180 lb-in. (20 Nm)
Flywheel Guard	30 lb-in. (3 Nm)
Fuel Tank	85 lb-in. (10 Nm)
Governor Lever Nut	45 lb-in. (5 Nm)
Muffler	100 lb-in. (11 Nm)
Muffler Support Bracket	45 lb-in. (5 Nm)
Oil Drain Cap – Front (Snow)	130 lb-in. (15 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	50 lb-in. (6 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Arm Stud	100 lb-in. (11 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Cover	20 lb-in. (2 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	55 lb-in. (6 Nm)
Snow Hood	40 lb-in. (5 Nm)
Snow Shield	50 lb-in. (6 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	.876 in. (22.25 mm)	.878 in. (22.30 mm)
Camshaft Bearing	.5008 in. (12.72 mm)	.5040 in. (12.80 mm)
Bore Diameter	2.688 in. (68.28 mm)	2.692 in. (68.38 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.249 in. (6.32 mm)	.267 in. (6.78 mm)
Intake Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
Exhaust Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.063 in. (27.00 mm)	1.065 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.098 in. (27.89 mm)	1.097 in. (27.86 mm)
Mag-Side Journal	.874 in. (22.20 mm)	.873 in. (22.17 mm)
PTO-Side Journal	1.061 in. (26.96 mm)	1.060 in. (26.92 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.112 in. (28.24 mm)	1.098 in. (27.29 mm)
Exhaust Lobes	1.112 in. (28.24 mm)	1.098 in. (27.29 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
<b>PISTON</b>		
Piston Pin	.6247 in. (15.86 mm)	.6242 in. (15.85 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
Ring End Gap (Top)	.006-.010 in. (.15-.25 mm)	.020 in. (.51 mm)
Ring End Gap (Middle)	.012-.020 in. (.30-.50 mm)	.030 in. (.76 mm)
Ring End Gap (Oil Control)	.020-.025 in. (.50-.63 mm)	.035 in. (.89 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.004 in. (.03-.07 mm)	.005 in. (.12 mm)

## MODEL 120000 HORIZONTAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .028 in. (.05 - .71 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.004 - .006 in. (.10 - .15 mm)
Valve Clearance – Exhaust	.009 - .011 in. (.23 - .28 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base / Backplate	40 lb-in. (5 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Bracket to Carburetor (Snow)	45 lb-in. (5 Nm)
Carburetor Bowl Screw	90 lb-in. (10 Nm)
Carburetor to Cylinder Head	85 lb-in. (10 Nm)
Connecting Rod	100 lb-in. (11 Nm)
Control Bracket	100 lb-in. (11 Nm)
Control Panel Trim	40 lb-in. (5 Nm)
Crankcase Cover	100 lb-in. (11 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Head Plate	100 lb-in. (11 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	180 lb-in. (20 Nm)
Flywheel Nut	100 lb-ft. (135 Nm)
Flywheel Fan	180 lb-in. (20 Nm)
Flywheel Guard	30 lb-in. (3 Nm)
Fuel Tank	85 lb-in. (10 Nm)
Governor Lever Nut	45 lb-in. (5 Nm)
Muffler	100 lb-in. (11 Nm)
Muffler Support Bracket	45 lb-in. (5 Nm)
Oil Drain Cap – Front (Snow)	130 lb-in. (15 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	50 lb-in. (6 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Arm Stud	100 lb-in. (11 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Cover	20 lb-in. (2 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	55 lb-in. (6 Nm)
Snow Hood	40 lb-in. (5 Nm)
Snow Shield	50 lb-in. (6 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	.876 in. (22.25 mm)	.878 in. (22.30 mm)
Camshaft Bearing	.5011 in. (12.72 mm)	.5040 in. (12.80 mm)
Bore Diameter	2.970 in. (75.44 mm)	2.974 in. (75.54 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.249 in. (6.32 mm)	.267 in. (6.78 mm)
Intake Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
Exhaust Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.063 in. (27.00 mm)	1.065 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.098 in. (27.89 mm)	1.097 in. (27.86 mm)
Mag-Side Journal	.874 in. (22.20 mm)	.876 in. (22.17 mm)
PTO-Side Journal	1.062 in. (26.96 mm)	1.060 in. (26.92 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.112 in. (28.24 mm)	1.098 in. (27.29 mm)
Exhaust Lobes	1.112 in. (28.24 mm)	1.098 in. (27.29 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Piston Pin Bearing	.6728 in. (17.09 mm)	.6742 in. (17.12 mm)
<b>PISTON</b>		
Piston Pin	.6722 in. (17.07 mm)	.6717 in. (17.06 mm)
Piston Pin Bearing	.6728 in. (17.09 mm)	.6742 in. (17.12 mm)
Ring End Gap (Top)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring End Gap (Middle)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring End Gap (Oil Control)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.001-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.004 in. (.05-.10 mm)	.005 in. (.12 mm)

## MODEL 150000 HORIZONTAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .028 in. (.05 - .71 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.004 - .006 in. (.10 - .15 mm)
Valve Clearance – Exhaust	.009 - .011 in. (.23 - .28 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base / Backplate	40 lb-in. (5 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Bracket to Carburetor (Snow)	45 lb-in. (5 Nm)
Carburetor Bowl Screw	90 lb-in. (10 Nm)
Carburetor to Cylinder Head	85 lb-in. (10 Nm)
Connecting Rod	100 lb-in. (11 Nm)
Control Bracket	100 lb-in. (11 Nm)
Control Panel Trim	40 lb-in. (5 Nm)
Crankcase Cover	100 lb-in. (11 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Head Plate	100 lb-in. (11 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	180 lb-in. (20 Nm)
Flywheel Nut	100 lb-ft. (135 Nm)
Flywheel Fan	180 lb-in. (20 Nm)
Flywheel Guard	30 lb-in. (3 Nm)
Fuel Tank	85 lb-in. (10 Nm)
Governor Lever Nut	45 lb-in. (5 Nm)
Muffler	100 lb-in. (11 Nm)
Muffler Support Bracket	45 lb-in. (5 Nm)
Oil Drain Cap – Front (Snow)	130 lb-in. (15 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	50 lb-in. (6 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Arm Stud	100 lb-in. (11 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Cover	20 lb-in. (2 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	55 lb-in. (6 Nm)
Snow Hood	40 lb-in. (5 Nm)
Snow Shield	50 lb-in. (6 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	.876 in. (22.25 mm)	.878 in. (22.30 mm)
Camshaft Bearing	.5011 in. (12.72 mm)	.5040 in. (12.80 mm)
Bore Diameter	2.970 in. (75.44 mm)	2.974 in. (75.54 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.249 in. (6.32 mm)	.267 in. (6.78 mm)
Intake Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
Exhaust Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.063 in. (27.00 mm)	1.065 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.098 in. (27.89 mm)	1.097 in. (27.86 mm)
Mag-Side Journal	.874 in. (22.20 mm)	.876 in. (22.17 mm)
PTO-Side Journal	1.062 in. (26.96 mm)	1.060 in. (26.92 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.112 in. (28.24 mm)	1.098 in. (27.29 mm)
Exhaust Lobes	1.112 in. (28.24 mm)	1.098 in. (27.29 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Piston Pin Bearing	.6728 in. (17.09 mm)	.6742 in. (17.12 mm)
<b>PISTON</b>		
Piston Pin	.6722 in. (17.07 mm)	.6717 in. (17.06 mm)
Piston Pin Bearing	.6728 in. (17.09 mm)	.6742 in. (17.12 mm)
Ring End Gap (Top)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring End Gap (Middle)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring End Gap (Oil Control)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.001-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.004 in. (.05-.10 mm)	.005 in. (.12 mm)



## MODEL 200000 HORIZONTAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .028 in. (.05 - .71 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.004 - .006 in. (.10 - .15 mm)
Valve Clearance – Exhaust	.004 - .006 in. (.10 - .15 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base / Backplate	90 lb-in. (10 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Bracket to Carburetor (Snow)	45 lb-in. (5 Nm)
Carburetor Bowl Screw / Solenoid	90 lb-in. (10 Nm)
Carburetor to Cylinder Head	85 lb-in. (10 Nm)
Connecting Rod	100 lb-in. (11 Nm)
Control Bracket	100 lb-in. (11 Nm)
Control Panel Trim	40 lb-in. (5 Nm)
Crankcase Cover	100 lb-in. (11 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	180 lb-in. (20 Nm)
Flywheel Nut	120 lb-ft. (160 Nm)
Flywheel Fan	140 lb-in. (16 Nm)
Flywheel Guard	30 lb-in. (3 Nm)
Fuel Tank	90 lb-in. (10 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Muffler	180 lb-in. (20 Nm)
Muffler Support Bracket	125 lb-in. (14 Nm)
Oil Drain Cap – Front (Snow)	130 lb-in. (15 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	30 lb-in. (3 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Arm Stud	100 lb-in. (11 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Cover	20 lb-in. (2 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	75 lb-in. (8 Nm)
Snow Hood	40 lb-in. (5 Nm)
Snow Shield	50 lb-in. (6 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	.876 in. (22.25 mm)	.878 in. (22.30 mm)
Camshaft Bearing	.5011 in. (15.88 mm)	.504 in. (12.80 mm)
Bore Diameter	2.688 in. (65.10 mm)	2.691 in. (68.33 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.249 in. (6.32 mm)	.267 in. (6.78 mm)
Intake Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
Exhaust Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.063 in. (27.00 mm)	1.065 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.098 in. (27.89 mm)	1.097 in. (27.86 mm)
Mag-Side Journal	.874 in. (22.19 mm)	.873 in. (22.17 mm)
PTO-Side Journal	1.0615 in. (26.96 mm)	1.060 in. (26.92 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
Exhaust Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
<b>PISTON</b>		
Piston Pin	.6247 in. (15.86 mm)	.6291 in. (15.98 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6311 in. (16.03 mm)
Ring End Gap (Top)	.006-.010 in. (.15-.25 mm)	.020 in. (.51 mm)
Ring End Gap (Middle)	.012-.025 in. (.30-.51 mm)	.020 in. (.76 mm)
Ring End Gap (Oil Control)	.020-.016 in. (.51-.63 mm)	.035 in. (.89 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.004 in. (.05-.10 mm)	.005 in. (.12 mm)

## MODEL 210000 HORIZONTAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .028 in. (.05 - .71 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.004 - .006 in. (.10 - .15 mm)
Valve Clearance – Exhaust	.004 - .006 in. (.10 - .15 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base / Backplate	90 lb-in. (10 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Bracket to Carburetor (Snow)	45 lb-in. (5 Nm)
Carburetor Bowl Screw / Solenoid	90 lb-in. (10 Nm)
Carburetor to Cylinder Head	85 lb-in. (10 Nm)
Connecting Rod	100 lb-in. (11 Nm)
Control Bracket	100 lb-in. (11 Nm)
Control Panel Trim	40 lb-in. (5 Nm)
Crankcase Cover	100 lb-in. (11 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	180 lb-in. (20 Nm)
Flywheel Nut	120 lb-ft. (160 Nm)
Flywheel Fan	140 lb-in. (16 Nm)
Flywheel Guard	30 lb-in. (3 Nm)
Fuel Tank	90 lb-in. (10 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Muffler	180 lb-in. (20 Nm)
Muffler Support Bracket	125 lb-in. (14 Nm)
Oil Drain Cap – Front (Snow)	130 lb-in. (15 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	30 lb-in. (3 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Arm Stud	100 lb-in. (11 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Cover	20 lb-in. (2 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	75 lb-in. (8 Nm)
Snow Hood	40 lb-in. (5 Nm)
Snow Shield	50 lb-in. (6 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	1.1825 in. (30.03 mm)	1.184 in. (30.07 mm)
Camshaft Bearing	.5011 in. (12.72 mm)	.5040 in. (12.80 mm)
Bore Diameter	3.300 in. (83.82 mm)	3.304 in. (83.92 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.236 in. (5.99 mm)	.240 in. (6.10 mm)
Intake Valve Stem Diameter	.234 in. (5.93 mm)	.233 in. (5.92 mm)
Exhaust Valve Stem Diameter	.234 in. (5.93 mm)	.233 in. (5.92 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.1825 in. (30.03 mm)	1.184 in. (30.07 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.2485 in. (31.71 mm)	1.2475 in. (31.68 mm)
Mag-Side Journal	1.1795 in. (29.95 mm)	1.178 in. (29.92 mm)
PTO-Side Journal	1.1795 in. (29.95 mm)	1.178 in. (29.92 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.216 in. (30.88 mm)	1.212 in. (30.77 mm)
Exhaust Lobes	1.216 in. (30.88 mm)	1.212 in. (30.77 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.250 in. (31.75 mm)	1.252 in. (31.80 mm)
Piston Pin Bearing	.6728 in. (17.09 mm)	.6742 in. (17.12 mm)
<b>PISTON</b>		
Piston Pin	.6722 in. (17.07 mm)	.6717 in. (17.06 mm)
Piston Pin Bearing	.6728 in. (17.09 mm)	.6742 in. (17.12 mm)
Ring End Gap (Top)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring End Gap (Middle)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring End Gap (Oil Control)	.008-.016 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.004 in. (.05-.10 mm)	.005 in. (.12 mm)

## MODELS 97700 & 99700 VERTICAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.006 - .012 in. (.15 - .30 mm)
Crankshaft End Play	.002 - .034 in. (.05 - .86 mm)
Spark Plug Gap	.030 in. (.76 mm)
Alternator Air Gap	.010 in. (.25 mm)
Valve Clearance – Intake	.005 - .007 in. (.13 - .18 mm)
Valve Clearance – Exhaust	.005 - .007 in. (.13 - .18 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base	35 lb-in. (4 Nm)
Alternator	40 lb-in. (5 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Breather	50 lb-in. (6 Nm)
Brake Bracket	40 lb-in. (5 Nm)
Carburetor Bowl Nut	50 lb-in. (6 Nm)
Carburetor to Cylinder Head	60 lb-in. (7 Nm)
Connecting Rod	100 lb-in. (11 Nm)
Crankcase Sump	90 lb-in. (10 Nm)
Cylinder Head	160 lb-in. (18 Nm)
Cylinder Head Plate	90 lb-in. (10 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	90 lb-in. (10 Nm)
Flywheel Nut	60 lb-ft. (80 Nm)
Fuel Tank (Side)	90 lb-in. (10 Nm)
Fuel Tank (Top)	40 lb-in. (5 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Muffler To Cylinder Head	90 lb-in. (10 Nm)
Muffler Guard	80 lb-in. (9 Nm)
Oil Drain Plug	100 lb-in. (11 Nm)
Oil Pump Cover	80 lb-in. (9 Nm)
Rewind Starter	55 lb-in. (6 Nm)
Rocker Arm Stud	110 lb-in. (12 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Cover	20 lb-in. (2 Nm)
Rocker Cover	65 lb-in. (7 Nm)
Rewind Pulley Screw	70 lb-in. (8 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	.876 in. (22.25 mm)	.878 in. (22.30 mm)
Camshaft Bearing	.625 in. (15.88 mm)	.622 in. (15.80 mm)
Bore Diameter	2.563 in. (65.10 mm)	2.567 in. (65.20 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.249 in. (6.32 mm)	.267 in. (6.78 mm)
Intake Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
Exhaust Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.063 in. (27.00 mm)	1.065 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.123 in. (28.53 mm)	1.122 in. (28.50 mm)
Mag-Side Journal	.874 in. (22.19 mm)	.873 in. (22.17 mm)
PTO-Side Journal	1.0615 in. (26.96 mm)	1.060 in. (26.92 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
Exhaust Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
<b>PISTON</b>		
Piston Pin	.6247 in. (15.86 mm)	.6291 in. (15.98 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6311 in. (16.03 mm)
Ring End Gap (Top)	.006-.010 in. (.15-.25 mm)	.020 in. (.51 mm)
Ring End Gap (Middle)	.012-.025 in. (.30-.51 mm)	.020 in. (.76 mm)
Ring End Gap (Oil Control)	.020-.016 in. (.51-.63 mm)	.035 in. (.89 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.004 in. (.05-.10 mm)	.005 in. (.12 mm)
<b>STARTER ROPE</b>		
Rope Size	#4	N/A
Rope Length	88.5 in. (2.2 Meters)	N/A

## MODEL 110000 VERTICAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .034 in. (.05 - .86 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.003 - .005 in. (.08 - .13 mm)
Valve Clearance – Exhaust	.005 - .007 in. (.13 - .18 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	<b>TORQUE</b>
Air Elbow	40 lb-in. (5 Nm)
Alternator	40 lb-in. (5 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Breather	70 lb-in. (8 Nm)
Brake Bracket	40 lb-in. (5 Nm)
Carburetor Bowl Nut	90 lb-in. (10 Nm)
Connecting Rod	100 lb-in. (11 Nm)
Crankcase Sump	100 lb-in. (11 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Head Plate	90 lb-in. (10 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	90 lb-in. (10 Nm)
Flywheel Nut	60 lb-ft. (80 Nm)
Fuel Tank (Side)	90 lb-in. (10 Nm)
Fuel Tank (Top)	40 lb-in. (5 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Muffler To Cylinder Head	90 lb-in. (10 Nm)
Oil Drain Plug	100 lb-in. (11 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Cover	20 lb-in. (2 Nm)
Starter Motor	90 lb-in. (10 Nm)
Rocker Cover (Die Cast)	90 lb-in. (10 Nm)
Rocker Cover (Stamped)	40 lb-in. (5 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	.876 in. (22.25 mm)	.878 in. (22.30 mm)
Camshaft Bearing	.5011 in. (12.72 mm)	.504 in. (12.80 mm)
Bore Diameter	2.688 in. (68.28 mm)	2.692 in. (68.38 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.249 in. (6.32 mm)	.267 in. (6.78 mm)
Intake Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
Exhaust Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.063 in. (27.00 mm)	1.065 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.123 in. (28.53 mm)	1.122 in. (28.50 mm)
Mag-Side Journal	.874 in. (22.19 mm)	.873 in. (22.17 mm)
PTO-Side Journal	1.0615 in. (26.96 mm)	1.060 in. (26.92 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
Exhaust Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
<b>PISTON</b>		
Piston Pin	.6247 in. (15.86 mm)	.6291 in. (15.98 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6311 in. (16.03 mm)
Ring End Gap (Top)	.006-.010 in. (.15-.25 mm)	.020 in. (.51 mm)
Ring End Gap (Middle)	.012-.025 in. (.30-.51 mm)	.020 in. (.76 mm)
Ring End Gap (Oil Control)	.020-.016 in. (.51-.63 mm)	.035 in. (.89 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.004 in. (.05-.10 mm)	.005 in. (.12 mm)



## MODEL 120000 VERTICAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .034 in. (.05 - .86 mm)
Spark Plug Gap	.020 in. (.50 mm)
Valve Clearance – Intake	.003 - .005 in. (.08 - .13 mm)
Valve Clearance – Exhaust	.005 - .007 in. (.13 - .18 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	<b>TORQUE</b>
Air Elbow	40 lb-in. (5 Nm)
Alternator	40 lb-in. (5 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Breather	70 lb-in. (8 Nm)
Brake Bracket	40 lb-in. (5 Nm)
Carburetor Bowl Nut	90 lb-in. (10 Nm)
Connecting Rod	100 lb-in. (11 Nm)
Crankcase Sump	100 lb-in. (11 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Head Plate	90 lb-in. (10 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	90 lb-in. (10 Nm)
Flywheel Nut	60 lb-ft. (80 Nm)
Fuel Tank (Side)	90 lb-in. (10 Nm)
Fuel Tank (Top)	40 lb-in. (5 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Muffler To Cylinder Head	90 lb-in. (10 Nm)
Oil Drain Plug	100 lb-in. (11 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Cover	20 lb-in. (2 Nm)
Starter Motor	90 lb-in. (10 Nm)
Rocker Cover (Die Cast)	90 lb-in. (10 Nm)
Rocker Cover (Stamped)	40 lb-in. (5 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	.876 in. (22.25 mm)	.878 in. (22.30 mm)
Camshaft Bearing	.5011 in. (12.72 mm)	.504 in. (12.80 mm)
Bore Diameter	2.688 in. (68.28 mm)	2.692 in. (68.38 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.249 in. (6.32 mm)	.267 in. (6.78 mm)
Intake Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
Exhaust Valve Stem Diameter	.247 in. (6.28 mm)	.244 in. (6.20 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.063 in. (27.00 mm)	1.065 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.123 in. (28.53 mm)	1.122 in. (28.50 mm)
Mag-Side Journal	.874 in. (22.19 mm)	.873 in. (22.17 mm)
PTO-Side Journal	1.0615 in. (26.96 mm)	1.060 in. (26.92 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
Exhaust Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
<b>PISTON</b>		
Piston Pin	.6247 in. (15.86 mm)	.6291 in. (15.98 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6311 in. (16.03 mm)
Ring End Gap (Top)	.006-.010 in. (.15-.25 mm)	.020 in. (.51 mm)
Ring End Gap (Middle)	.012-.025 in. (.30-.51 mm)	.020 in. (.76 mm)
Ring End Gap (Oil Control)	.020-.016 in. (.51-.63 mm)	.035 in. (.89 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.004 in. (.05-.10 mm)	.005 in. (.12 mm)

## MODEL 210000 VERTICAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .034 in. (.05 - .86 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.003 - .005 in. (.08 - .13 mm)
Valve Clearance – Exhaust	.005 - .007 in. (.13 - .18 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base	50 lb-in. (6 Nm)
Alternator	20 lb-in. (2 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Breather	60 lb-in. (7 Nm)
Breather Reed	40 lb-in. (5 Nm)
Carburetor to Intake Manifold	70 lb-in. (8 Nm)
Carburetor Solenoid	40 lb-in. (5 Nm)
Connecting Rod	175 lb-in. (20 Nm)
Control Bracket	45 lb-in. (5 Nm)
Crankcase Sump	175 lb-in. (20 Nm)
Cylinder Head	240 lb-in. (27 Nm)
Cylinder Shield	30 lb-in. (3 Nm)
Exhaust Manifold / Adapter	45 lb-in. (5 Nm)
Flywheel Nut	100 lb-ft. (135 Nm)
Flywheel Fan	140 lb-in. (16 Nm)
Fuel Pump	90 lb-in. (10 Nm)
Fuel Tank	180 lb-in. (20 Nm)
Fuel Tank Bracket	180 lb-in. (20 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Intake Manifold to Cylinder Head	90 lb-in. (10 Nm)
Muffler	140 lb-in. (16 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	140 lb-in. (16 Nm)
Oil Pump Cover	90 lb-in. (10 Nm)
Regulator / Rectifier	40 lb-in. (5 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	70 lb-in. (8 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	1.3795 in. (35.04 mm)	1.383 in. (35.13 mm)
Camshaft Bearing	.5011 in. (15.88 mm)	.504 in. (12.80 mm)
Bore Diameter	3.437 in. (87.30 mm)	3.441 in. (87.40 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.237 in. (6.02 mm)	.240 in. (6.10 mm)
Intake Valve Stem Diameter	.235 in. (5.97 mm)	.233 in. (5.92 mm)
Exhaust Valve Stem Diameter	.235 in. (5.97 mm)	.233 in. (5.92 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.6265 in. (41.31 mm)	1.629 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.4985 in. (38.06 mm)	1.497 in. (38.02 mm)
Mag-Side Journal	1.3775 in. (34.99 mm)	1.376 in. (34.95 mm)
PTO-Side Journal	1.6245 in. (41.26 mm)	1.623 in. (41.22 mm)
Eccentrics	2.2045 in. (55.91 mm)	2.202 in. (55.93 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
Exhaust Lobes	1.112 in. (28.24 mm)	1.098 in. (27.89 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.500 in. (38.10 mm)	1.502 in. (27.99 mm)
Piston Pin Bearing	.8006 in. (20.33 mm)	.802 in. (20.37 mm)
<b>COUNTERWEIGHT SYSTEM</b>		
AVS Bearing – Large End	2.207 in. (56.05 mm)	2.210 in. (56.13 mm)
AVS Bearing – Small End	.490 in. (12.40 mm)	.493 in. (12.52 mm)
<b>PISTON</b>		
Piston Pin	.7998 in. (20.31 mm)	.799 in. (20.29 mm)
Piston Pin Bearing	.8006 in. (20.33 mm)	.802 in. (20.37 mm)
Ring End Gap (Top)	.006-.009 in. (.15-.23 mm)	.030 in. (.76 mm)
Ring End Gap (Middle)	.014-.018 in. (.35-.45 mm)	.030 in. (.76 mm)
Ring End Gap (Oil Control)	.006-.010 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring Land Clearance (Top)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)
Ring Land Clearance (Middle)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)
Ring Land Clearance (Oil Control)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)

## MODEL 280000 VERTICAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .023 in. (.05 - .58 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.003 - .005 in. (.08 - .13 mm)
Valve Clearance – Exhaust	.005 - .007 in. (.13 - .18 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base	50 lb-in. (6 Nm)
Alternator	20 lb-in. (2 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housings	90 lb-in. (10 Nm)
Blower Housing Brackets	90 lb-in. (10 Nm)
Breather	30 lb-in. (3 Nm)
Carburetor to Intake Manifold	70 lb-in. (8 Nm)
Carburetor Solenoid	40 lb-in. (5 Nm)
Connecting Rod	150 lb-in. (17 Nm)
Control Bracket	30 lb-in. (3 Nm)
Crankcase Cover	220 lb-in. (25 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Shield	40 lb-in. (5 Nm)
Exhaust Manifold / Adapter	165 lb-in. (19 Nm)
Flywheel Nut	100 lb-ft. (135 Nm)
Flywheel Fan	140 lb-in. (16 Nm)
Fuel Pump	90 lb-in. (10 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Intake Manifold to Cylinder Head	90 lb-in. (10 Nm)
Muffler	90 lb-in. (10 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	90 lb-in. (10 Nm)
Oil Pump Cover	90 lb-in. (10 Nm)
Regulator / Rectifier	40 lb-in. (5 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Clutch	65 lb-ft. (88 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	60 lb-in. (7 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	1.3795 in. (35.04 mm)	1.383 in. (35.13 mm)
Camshaft Bearing	.5011 in. (15.88 mm)	.504 in. (12.80 mm)
Bore Diameter	3.437 in. (87.30 mm)	3.441 in. (87.40 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.237 in. (6.02 mm)	.240 in. (6.10 mm)
Intake Valve Stem Diameter	.235 in. (5.97 mm)	.233 in. (5.92 mm)
Exhaust Valve Stem Diameter	.235 in. (5.97 mm)	.233 in. (5.92 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.3795 in. (35.03 mm)	1.383 in. (35.13 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.098 in. (27.89 mm)	1.097 in. (27.86 mm)
Mag-Side Journal	1.3775 in. (35.00 mm)	1.376 in. (34.95 mm)
PTO-Side Journal	1.3775 in. (35.00 mm)	1.376 in. (34.95 mm)
Eccentrics	2.2045 in. (55.91 mm)	2.202 in. (55.93 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.240 in. (31.49 mm)	1.234 in. (31.34 mm)
Exhaust Lobes	1.240 in. (31.49 mm)	1.234 in. (31.34 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.2505 in. (31.76 mm)	1.2525 in. (31.81 mm)
Piston Pin Bearing	.8006 in. (20.33 mm)	.802 in. (20.37 mm)
<b>COUNTERWEIGHT SYSTEM</b>		
Bearings	2.207 in. (56.05 mm)	2.210 in. (56.13 mm)
<b>PISTON</b>		
Piston Pin	.7998 in. (20.31 mm)	.799 in. (20.29 mm)
Piston Pin Bearing	.8006 in. (20.33 mm)	.802 in. (20.37 mm)
Ring End Gap (Top)	.006-.009 in. (.15-.23 mm)	.030 in. (.76 mm)
Ring End Gap (Middle)	.014-.018 in. (.35-.45 mm)	.030 in. (.76 mm)
Ring End Gap (Oil Control)	.006-.010 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring Land Clearance (Top)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)
Ring Land Clearance (Middle)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)
Ring Land Clearance (Oil Control)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)
<b>STARTER ROPE</b>		
Rope Size	#5.5	N/A
Rope Length	63.0 " (1.6 meters)	N/A

## MODEL 310000 VERTICAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.010 - .014 in. (.25 - .36 mm)
Crankshaft End Play	.002 - .023 in. (.05 - .58 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.003 - .005 in. (.08 - .13 mm)
Valve Clearance – Exhaust	.005 - .007 in. (.13 - .18 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base	50 lb-in. (6 Nm)
Alternator	20 lb-in. (2 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housings	90 lb-in. (10 Nm)
Blower Housing Brackets	90 lb-in. (10 Nm)
Breather	30 lb-in. (3 Nm)
Carburetor to Intake Manifold	70 lb-in. (8 Nm)
Carburetor Solenoid	40 lb-in. (5 Nm)
Connecting Rod	150 lb-in. (17 Nm)
Control Bracket	30 lb-in. (3 Nm)
Crankcase Sump	220 lb-in. (25 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Shield	40 lb-in. (5 Nm)
Exhaust Manifold / Adapter	165 lb-in. (19 Nm)
Flywheel Nut	100 lb-ft. (135 Nm)
Flywheel Fan	140 lb-in. (16 Nm)
Fuel Pump	90 lb-in. (10 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Intake Manifold to Cylinder Head	90 lb-in. (10 Nm)
Muffler	90 lb-in. (10 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	90 lb-in. (10 Nm)
Oil Pump Cover	90 lb-in. (10 Nm)
Regulator / Rectifier	40 lb-in. (5 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	60 lb-in. (7 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	1.3795 in. (35.04 mm)	1.383 in. (35.13 mm)
Camshaft Bearing	.5011 in. (15.88 mm)	.504 in. (12.80 mm)
Bore Diameter	3.563 in. (90.50 mm)	3.567 in. (90.60 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.237 in. (6.02 mm)	.240 in. (6.10 mm)
Intake Valve Stem Diameter	.235 in. (5.97 mm)	.233 in. (5.92 mm)
Exhaust Valve Stem Diameter	.235 in. (5.97 mm)	.233 in. (5.92 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.063 in. (27.00 mm)	1.065 in. (27.05 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.4982 in. (38.05 mm)	1.497 in. (31.02 mm)
Mag-Side Journal	1.3775 in. (35.00 mm)	1.376 in. (34.95 mm)
PTO-Side Journal	1.3775 in. (35.00 mm)	1.376 in. (34.95 mm)
Eccentrics	2.2045 in. (55.91 mm)	2.202 in. (55.93 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.240 in. (31.49 mm)	1.234 in. (31.34 mm)
Exhaust Lobes	1.240 in. (31.49 mm)	1.234 in. (31.34 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.2505 in. (31.76 mm)	1.2525 in. (31.81 mm)
Piston Pin Bearing	.8006 in. (20.33 mm)	.802 in. (20.37 mm)
<b>COUNTERWEIGHT SYSTEM</b>		
Bearings	2.207 in. (56.05 mm)	2.210 in. (56.13 mm)
<b>PISTON</b>		
Piston Pin	.7998 in. (20.31 mm)	.799 in. (20.29 mm)
Piston Pin Bearing	.8006 in. (20.33 mm)	.802 in. (20.37 mm)
Ring End Gap (Top)	.006-.009 in. (.15-.23 mm)	.030 in. (.76 mm)
Ring End Gap (Middle)	.014-.018 in. (.35-.45 mm)	.030 in. (.76 mm)
Ring End Gap (Oil Control)	.006-.010 in. (.15-.25 mm)	.030 in. (.76 mm)
Ring Land Clearance (Top)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)
Ring Land Clearance (Middle)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)
Ring Land Clearance (Oil Control)	.002-.005 in. (.05-.12 mm)	.007 in. (.18 mm)



## MODEL 330000 VERTICAL SERIES

<b>ENGINE SPECIFICATIONS</b>	
Armature Air Gap	.008 - .012 in. (.20 - .30 mm)
Crankshaft End Play	.002 - .020 in. (.05 - .51 mm)
Spark Plug Gap	.030 in. (.76 mm)
Valve Clearance – Intake	.003 - .005 in. (.08 - .13 mm)
Valve Clearance – Exhaust	.003 - .005 in. (.08 - .13 mm)
<b>FASTENER TORQUE SPECIFICATIONS</b>	
	<b>TORQUE</b>
Air Cleaner Base	50 lb-in. (6 Nm)
Alternator	20 lb-in. (2 Nm)
Armature	30 lb-in. (3 Nm)
Blower Housing	90 lb-in. (10 Nm)
Breather	30 lb-in. (3 Nm)
Carburetor to Intake Manifold	70 lb-in. (8 Nm)
Carburetor Solenoid	40 lb-in. (5 Nm)
Connecting Rod	150 lb-in. (17 Nm)
Control Bracket	30 lb-in. (3 Nm)
Crankcase Sump	220 lb-in. (25 Nm)
Cylinder Head	220 lb-in. (25 Nm)
Cylinder Shield	40 lb-in. (5 Nm)
Exhaust Manifold / Adapter	165 lb-in. (19 Nm)
Flywheel Nut	100 lb-ft. (135 Nm)
Flywheel Fan	140 lb-in. (16 Nm)
Fuel Pump	90 lb-in. (10 Nm)
Governor Lever Nut	40 lb-in. (5 Nm)
Intake Manifold to Cylinder Head	90 lb-in. (10 Nm)
Muffler	90 lb-in. (10 Nm)
Oil Drain Plug – Side	100 lb-in. (11 Nm)
Oil Fill Tube	90 lb-in. (10 Nm)
Oil Pump Cover	90 lb-in. (10 Nm)
Regulator / Rectifier	40 lb-in. (5 Nm)
Rewind Starter	30 lb-in. (3 Nm)
Rocker Ball Set Screw or Nut	45 lb-in. (5 Nm)
Spark Plug	180 lb-in. (20 Nm)
Starter Motor	140 lb-in. (16 Nm)
Rocker Cover	60 lb-in. (7 Nm)

REJECT DIMENSIONS	STANDARD SIZE	REJECT SIZE
<b>CYLINDER</b>		
Main Bearing	1.6248 in. (41.27 mm)	1.629 in. (41.38 mm)
Camshaft Bearing	.5011 in. (15.88 mm)	.504 in. (12.80 mm)
Bore Diameter	3.701 in. (94.01 mm)	3.705 in. (94.11 mm)
Bore Out-Of-Round	N/A	.0015 in. (.04 mm)
<b>CYLINDER HEAD</b>		
Valve Guide	.237 in. (6.02 mm)	.240 in. (6.10 mm)
Intake Valve Stem Diameter	.235 in. (5.97 mm)	.233 in. (5.92 mm)
Exhaust Valve Stem Diameter	.235 in. (5.97 mm)	.233 in. (5.92 mm)
<b>CYLINDER COVER</b>		
Main Bearing	1.6248 in. (41.27 mm)	1.629 in. (41.38 mm)
Camshaft Bearing	.501 in. (12.72 mm)	.504 in. (12.80 mm)
<b>CRANKSHAFT</b>		
Crank Pin Journal	1.6235 in. (41.24 mm)	1.6225 in. (41.21 mm)
Mag-Side Journal	1.6235 in. (41.24 mm)	1.6225 in. (41.21 mm)
PTO-Side Journal	1.6235 in. (41.24 mm)	1.6225 in. (41.21 mm)
Eccentrics	2.681 in. (68.10 mm)	2.6793 in. (68.05 mm)
<b>CAMSHAFT</b>		
Mag-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
PTO-Side Journal	.499 in. (12.67 mm)	.498 in. (12.65 mm)
Intake Lobes	1.240 in. (31.49 mm)	1.234 in. (31.34 mm)
Exhaust Lobes	1.240 in. (31.49 mm)	1.234 in. (31.34 mm)
<b>CONNECTING ROD</b>		
Crank Pin Bearing	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
<b>COUNTERWEIGHT SYSTEM</b>		
Pivot Shaft Bore	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Counterweight Pin Bore	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Link Pin	1.100 in. (37.06 mm)	1.102 in. (27.99 mm)
Connector Link Bore	1.100 in. (37.06 mm)	1.100 in. (27.99 mm)
Eccentric Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
<b>PISTON</b>		
Piston Pin	.6247 in. (15.86 mm)	.6242 in. (15.85 mm)
Piston Pin Bearing	.6258 in. (15.89 mm)	.6268 in. (15.92 mm)
Ring End Gap (Top)	.006-.010 in. (.15-.35 mm)	.020 in. (.51 mm)
Ring End Gap (Middle)	.012-.020 in. (.30-.51 mm)	.030 in. (.76 mm)
Ring End Gap (Oil Control)	.020-.025 in. (.50-.63 mm)	.035 in. (.89 mm)
Ring Land Clearance (Top)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Middle)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)
Ring Land Clearance (Oil Control)	.002-.003 in. (.05-.08 mm)	.004 in. (.10 mm)

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